VOLUME 85, No. 3

STEAM GENERATION
POWER GENERATION
WATER POWER
DIESEL & GAS ENGINES
AIR CONDITIONING & HEATING
REFRIGERATION
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MARCH, 1941

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Publication office: 99-129 North Broadway, Albany, N. Y.
Editorial & Executive Offices: 330 West 42nd St., New York, N. Y.

CHICAGO, 520 North Michigan Ave.
SAN FRANCISCO, 68 Post St.
WASHINGTON, National Press Bldg.
PHILADELPHIA, 16 South Broad St.
CLEVELAND, 1510 Hanna Bldg.
DETROIT, 2-144 General Motors Bldg.
ST. LOUIS, 455 Paul Brown Bldg.
BOSTON, 1427 Statler Bldg.
ATLANTA, 1011 Rhodes Haverty Bldg.
LONDON, Aldwych House, Aldwych, London, W C.2

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POWER articles are currently indexed in both the Industrial Arts and the Engineering Indexes, available at public libraries. Also every year POWER issues an annual index of its own. Cable Address: "McGraw-Hill, N. Y."

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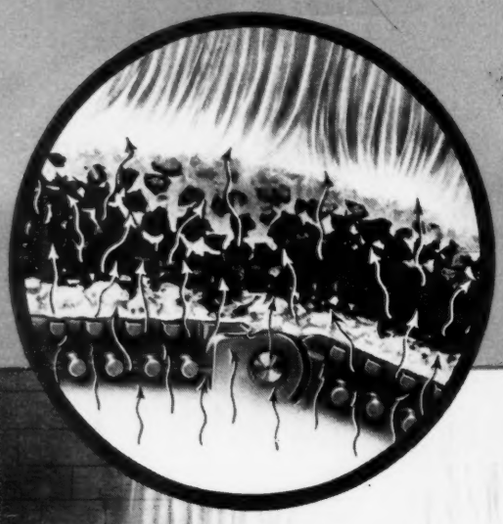
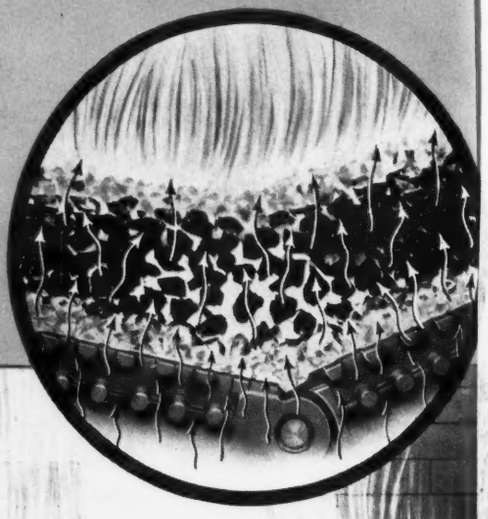
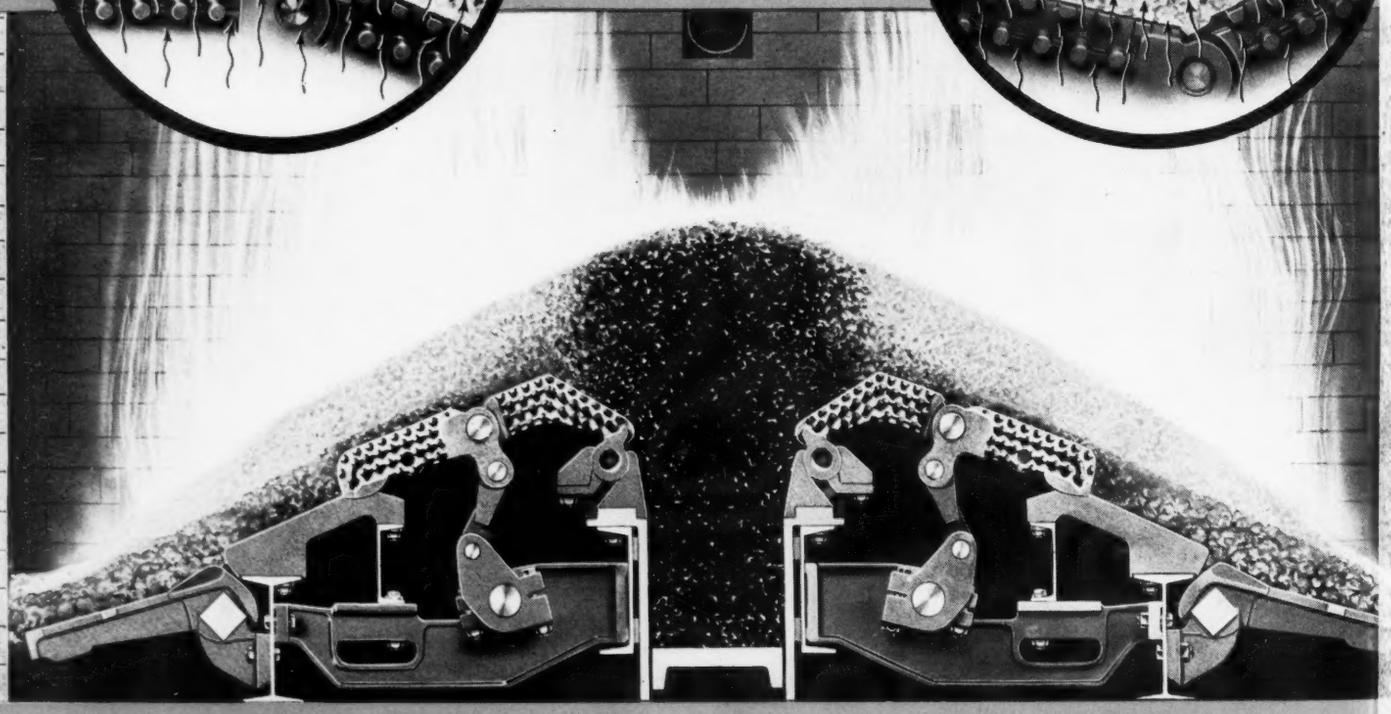
Link-Grate opens passages in fuel bed to give adequate air flow for efficient combustion and cool grates.

GRATES DOWN

Link-Grate cracks fuel bed and prevents formation of large troublesome clinkers. Fuel bed is moved forward.







Link-Grates, in a single retort stoker, combine a vertical or agitating movement with a horizontal or conveying movement, resulting in a continuous wave-like motion which processes the fuel bed and keeps it porous.

Westinghouse

POWER

Established 1882 • PHILIP W SWAIN, Editor

Building a Boss

To train future executives for American industry, the better engineering schools are now concentrating more on the "fundamentals", less on details of application. They teach the boys english, math, physics, chemistry and economics, rather than how to design a code boiler and set a valve.

So far this is all to the good. Only so much can be taught in four years. The precious time is best spent on those school-book fundamentals with the widest application in engineering work.

But some of the professors fall into an error when they let the boys graduate with the notion that a sound literary and scientific education, plus a few years of experience, will set them on the road to engineering success. They should tell them that even a lifetime of experience will not convert a graduate into a *real* engineer unless the experience is of the right sort.

Far too often the young man just out of technical school avoids the plant as a supposedly disagreeable and low-grade start. Instead he picks the drafting room or the office for his take off—a white-collar job one step closer (he imagines) to the goal of his dreams, an executive position with a mahogany desk and two secretaries.

This is a great mistake; neither the drafting room nor the office is the best place to start a plant career. That place is at the bench or on the machine, working side by side with the men he hopes to direct some day. Nowhere else can he get to know plant men, their problems, their point of view. If he doesn't know these things he can never become a competent mechanical executive. And nowhere, except in the plant, can he get that "feel" for processes, materials and machines which is the hall mark of the first-class designer.

After long observation of American plants and plant men, I am convinced that some of our industries are suffering severely from "stuffed shirtism", from operating executives who don't understand their plants or the men who operate them.

The only cure I can see for this situation is that no man, whether he be a college graduate or not, be appointed a mechanical executive unless he has worked up the mechanical line from the bottom. When that becomes standard practice, there will be fewer bluffers up and down the line, greater efficiency, lower costs, far better labor relations.

The majority of plant workers have little prejudice against college men as such. What does gripe them is to have the college man placed in charge of work he does not understand. They feel, and rightly so, that neither a degree nor a family connection should win a man authority over them unless he knows his stuff.—*PWS*

FPC Reports Basic Data

TABLE I—GENERATING STATIONS—POWER-SUPPLY AREA NO. 7

Company and Station	Installed Capacity — kw	Dependable Capacity — kw
AMERICAN WATER WORKS SYSTEM		
Springdale	210,000	
Connellsville	55,500	
Ridgway	13,000	
Windsor	90,000	
Rivesville	65,000	
Parkersburg	10,000	
Williamsport	45,000	
Cumberland	39,000	
Others (steam)	30,225	
Others (int comb.)	1,939	
Total Fuel	559,664	594,879
Lake Lynn	50,000	
Others (hydro)	7,390	
Total Hydro	57,390	54,025
Total System	617,054	648,904*
DUQUESNE LIGHT CO		
Colfax	262,500	
James H Reed	120,000	
Brunot Island	116,500	
Stanwix	5,000	
Total System	504,000	519,500
KEYSTONE PUBLIC SERVICE CO		
Oil City	17,500	
Others (int comb.)	1,060	
Total System	18,560	13,760
PENNSYLVANIA EDISON CO		
Saxton	50,000	
Williamsburg	17,000	
Warrior Ridge	6,500	
Barnesboro	2,600	
Total Fuel	76,100	76,100
Raystown	2,100	
Warrior Ridge	2,000	
Total Hydro	4,100	1,032
Total System	80,200	77,132
PENNSYLVANIA ELECTRIC CO		
Seward	54,000	
Johnstown	1,400	
Phillipsburg	6,500	
Clearfield	300	
Front St	31,000	
Peach St	8,500	
Brookville (int comb.)	561	
Total Fuel	102,261	100,900
Piney	28,800	
Deep Creek	19,200	
Total Hydro	48,000	26,000
Total System	150,261	126,900

* *Includes 30,000 kilowatts available from Unit No. 7 of the Ohio Power Company in the Windsor Station.*

Regional load and capacity compiled by Federal Power Commission uses utilities, own estimates of dependable output and reserves. Analysis of Pittsburgh district presented here indicates method of calculation applied to all areas

▶ DEFENSE INDUSTRIES have a vital stake in the ability of utility companies to meet power demands imposed by rapidly expanding production. A sizable share of the Army and Navy orders will be produced in plants that make, or will make, their own electric power and steam, but by far the larger part of the increase in electric power load must be met effectively and quickly by the utilities which have power-generating facilities available.

Any discussion of the defense program and its effect on peak loads of 1941 and 1942 must be based on factual data as to present loads, dependable capacity, construction program for additions and extensions, and interconnection limitations. Present loads and capacities are facts of record subject only to opinion as to operating condition of equipment, ability to carry actual loads up to and above nameplate rating for steam units, or water available in the case of hydro installations. Future loads, however, depend on the regional distribution of defense production, effect of defense orders on normal production and impact of billions of dollars

TABLE II—ELECTRIC POWER SUPPLY AND

	Electric Generating Capacity — Installed			Electric Generating Capacity — Dependable			Net Firm Power Purchased	Required Reserve as Reported	Net Assured Capacity
	Fuel Kw	Hydro Kw	Total Kw	Fuel Kw	Hydro Kw	Total Kw			
AMERICAN WATER WORKS SYSTEM	559,664	57,390	617,054	594,879	54,025	648,904	8,200	88,000	569,104
DUQUESNE LIGHT CO	504,000	0	504,000	519,500	0	519,500	0	46,000*	473,500
KEYSTONE PUBLIC SERVICE CO	18,560	0	18,560	13,760	0	13,760	6,000	1,060	18,700
PENNSYLVANIA EDISON CO	76,100	4,100	80,200	76,100	1,032	77,132	−7,500	12,600	57,032
PENNSYLVANIA ELECTRIC SYSTEM	102,261	48,000	150,261	100,900	26,000	126,900	−6,000	0	120,900
Totals	1,260,585	109,490	1,370,075	1,305,139	81,057	1,386,196	700	147,660	1,239,236

* *Additional required reserve capacity of 20,000 kw reported to be available from West Penn Power Co*

for Defense Power Needs

on the economic machinery of many industrial communities.

Basic data on installed generating capacity, reserves and peak loads up to December, 1940, are presented in a report recently issued by the Federal Power Commission. This report, more complete than earlier tabulations, enables segregation of the relatively few critical areas from a power-supply standpoint, and presents sufficient information to determine the present and future status of the power situation within each geographical district.

It has not been practical within the report itself to give enough explanatory tabulation and reference which would enable a complete check of the methods of computing assured capacities. The source material is deriv 1 primarily from data supplied to the Commission by the utility companies.

Some 50 charts, similar to Fig. 2, present a summation of loads and capacities for corresponding geographical districts, Fig. 1. While it is impractical to give the background data for all areas, an analysis of one typical district will illustrate the methods applied to all.

The so-called Pittsburgh area (Fig. 1), representing an area of heavy defense production, includes several interconnected electric systems. This district, Power-Supply Area No. 7 of the FPC report, is served by five principal electric systems having steam, hydro and internal-combustion engine plants as shown in Table I. Installed capacity has been reported as the total of name-plate ratings for hydro as well as fuel kw.

Effective capacity at time of peak loads may differ from name-plate or adverse-stream-flow ratings. Colder circulating water, for example, with resulting better vacuum, permits higher "dependable" winter rating (of such stations as Colfax) than in summer. Pondage of hydro units can be computed for peak conditions. Each company's own statement of its "dependable" capacity has been summarized to obtain dependable supply for the area as indicated in Table II, in which capacity totals are shown for each system.

Table II also shows the amount of required reserve for peak periods re-

REQUIREMENTS

Load Data for December, 1940

Peak Demand Kw	*Energy for Load 1000 Kwhr*	*Net Generation 1000 Kwhr*
523,300	265,034	259,299
463,400	233,471	233,291
15,700	6,949	5,265
62,225	28,492	31,845
109,562	48,265	49,811
1,174,187	582,211	579,511

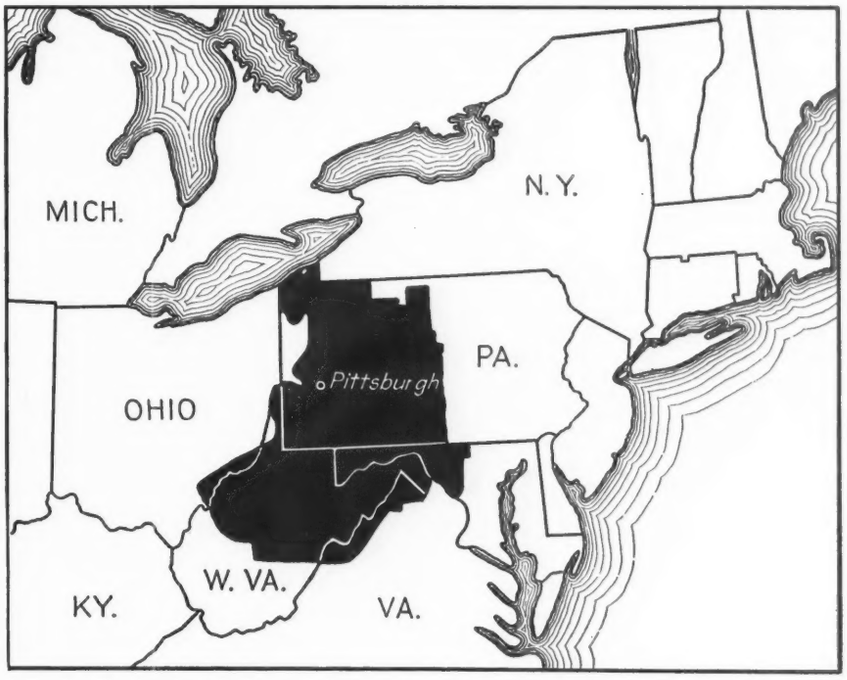


Fig. 1—Geographical areas represent electric power systems rather than state boundaries. Each area like this one, No. 7, may include several operating companies

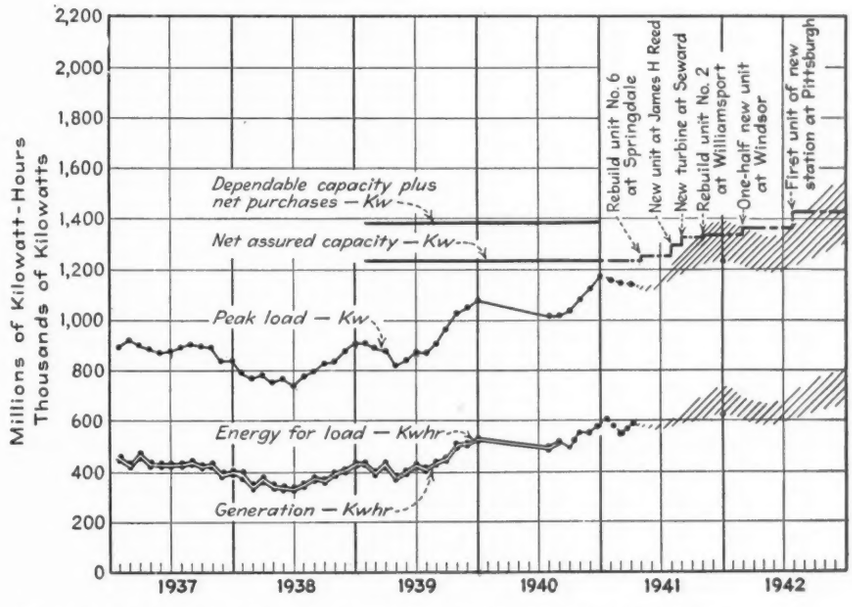


Fig. 2—Peak loads for December, 1940, were highest in the history of the industry. Estimates of 1942 loads range within shaded limits for Power Supply Area No. 7

TABLE III—SCHEDULED INSTALLATIONS

Date	*Add— Kw*	*Source*	*Net Assured Capacity, Kw*
December, 1940	.....	.....	1,239,236
April, 1941	10,000	Rebuild Springdale Unit No. 6	1,249,236
July, 1941	60,000	New unit at James H Reed	1,309,236
August, 1941	17,000	New turbine at Seward*	1,326,236
October, 1941	5,000	Rebuild Williamsport Unit No. 2	1,331,236
February, 1942	27,096	One-half new unit at Windsor**	1,358,332
July, 1942	60,000	Frank R Phillips station, Wireton, Pa.	1,418,332

** New 35,000-kw turbine with no scheduled increase in boiler capacity. Present boiler sufficient to increase net assured capacity by 17,000 kw*

*** Net addition to American Water Works System after deducting 2904 kw increase in required reserve and releasing to Ohio Power Co the 30,000 kw available from Unit No. 7*

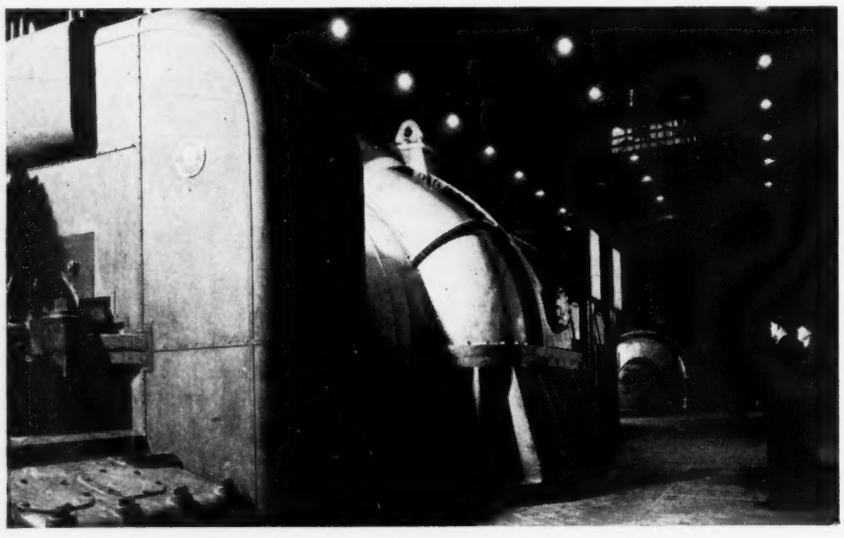


Fig. 3—Another 60,000-kw unit like the 1939 installation shown will start producing power for defense in July, 1941. Location is James H Reed Station of Duquesne Light Co, Pittsburgh. Nearly 2,500,000 kw of steam-plant is scheduled to operate in 1941

ported by operating companies, taking into account effective interconnections. The amounts of reserve vary widely, depending on the policies of the several systems; it is important to note that the charts have been based on operating companies' reports.

Firm purchases and sales have been accounted for as indicated in Table II. Some discrepancies between reported sales and purchases have required adjustment to common values but these have, in general, represented only minor portions of the totals.

Regional Charts

Fig. 2, a chart for Power-Supply Area No. 7, is typical of the 50 that make up the FPC report. Solid lines to the left of December, 1940, indicate the facts of record, both as to total capacity, net assured capacity, and load. Future conditions, to the right, involve estimates and opinions, construction schedules, priorities, direct and indirect effects of defense purchasing. They must be viewed as changing from month to month. The Federal Power Commission has announced its intention of summarizing the tabulated data each month and revising the complete report, including charts, quarterly.

Nearly six million kw of generating capacity are now on order for installation and operation by 1942. Other additions may be expected from rebuilding turbines and stepping up boilers. A schedule of increases for each power-supply area is indicated on the charts, both as to amount of added capacity and date of expected operation. These too are plotted on the charts just as reported by the utilities.

For area No. 7, a more complete statement than appears in the report, Table III and Fig. 2, indicates the manner of compilation for all areas. Table III shows the location, amount and type of each addition to capacity. Reported changes in reserves are also taken into account.

Future peak loads and kwhr generation will depend on more complex factors than ever before. Even in normal years, estimating future demands as a basis for purchasing new capacity has required placing a range of probable variation on such estimates. It takes about two years to make a major addition to generating capacity, and the margin of possible error for a 2-year estimate is great in proportion to the increases expected.

In previous reports, charts have appeared with peak loads and kwhr generation forecasts for the following three months and for the high regional peak of the following 12-month period. These forecasts were summarized from the reports of utility companies.

The current report, however, presents one added item of great interest to engineers concerned with locally generated industrial power loads as well as to those who purchase power. The FPC staff calculation of the distributed effect of combined normal growth and additional power needs for defense production has been added to the graph of peak loads as a shaded area. The lower limit of the shaded area has been based on the totalized forecasts estimated by the utilities, extended to 1942, as their figures have appeared to be, perhaps unintentionally, conservative.

Load Forecasts

FPC calculations indicate that much higher peak loads should be considered. On the necessary assumption that present defense production schedules will be carried out, power loads and generated kwhr can, and probably will, increase at a more rapid rate than expected up to now. The results of the FPC's own forecast forms the upper limit of the shaded area.

This analysis is, of course, subject to a plus-or-minus variation just as in any other forecast. It has, however, been used as an upper limit for the curve of prospective peaks to represent a condition of loads and kwhr that should be provided for if there is to be no limitation of available electric power for assured defense production.

The shaded areas, subject to variation from future events over which the estimators have neither accurate knowledge or control, indicate which industrial areas may be lacking in adequate assured electric supply. Likewise, other areas are obviously prepared to take care of any amount of defense production that might be expected to locate within their boundaries.

The present FPC report does not point to any imminent or vital lack of power-generating facilities, but rather summarizes what is now known of capacity and potential load conditions. This summary may be taken as an indication of what preparations might justifiably be undertaken, on a regional basis, and by well considered long range planning to insure against limitation of the defense program.

The War Against Time

A report on the defense situation, based on first-hand investigation, shows that the nation's prime job is to get out as much defense production as possible right now with existing facilities

The immediate defense crisis must be met with what the nation can turn out with the facilities it *now* has, which means day-and-night operation of every machine now available. Meanwhile, power equipment coming off production lines, such as this at Westinghouse, is building capacity for the enormous long-range defense program

▶ THE FACTS STATED on this page are known to be facts. The opinions expressed are POWER's, but are known to be held by more than 90% of the responsible men in government and by practically all of the many outstanding industrialists who have assumed national defense responsibilities on a strictly non-partisan basis:

1. A military crisis in England is expected this spring. The "betting odds" are slightly in favor of England surviving this primary blow.

2. If England goes down the international threat to American interests will be critical. This does not imply any early attempt to invade the United States. If England survives the summer there will remain an extremely serious long-pull military situation in which vital American interests will be at stake.

3. Either way, defense authorities in every branch, and of every shade of political opinion, see two defense jobs:

The Quick Dash First

4. First is the "race against time", *to get out as much defense production as possible right now with existing facilities*, specifically to meet the expected early military crisis abroad.

5. Second is the gigantic job of building facilities and output for an impregnable national defense after the first crisis has passed.

6. For this first requirement we can get no help from the big powder and gun plants now going up, or from the battleships now being laid, or from the current expansion of machine-tool plant.

7. The immediate defense crisis must be met with what we can turn out *with the facilities we now have*. That means night-and-day operation of every machine now available to produce the immediate requirements of defense. And that, in turn, means a lot of subcontracting in a hurry.

8. A survey indicates that about 40% of the work on prime defense contracts could be farmed out to other plants as pieces and sub-assemblies. A subcontracting office has been set up in each of the 35 Federal Reserve Bank district headquarters. With government blueprints in the bank vaults, and trained full-time production engineers at hand, prime contractors can sit down at these tables with local manufacturers who might pick up some of their load in the form of subcontracts.

9. Management and labor are cooperating on defense better than would appear from newspaper emphasis on isolated conflicts. Still more cooperation is needed, and the responsible leaders of labor and industry are working to that end—also the National Labor Relations Board under its new leadership.

10. So far the long-range defense program has been mostly brick and mortar, but is now swinging into the tooling stage. It will be another six months before defense goods will be coming out of these plants in worthwhile quantities.

11. Defense accomplishments to date have met all reasonable expectations, but still more speed is needed. American industry is asked to perform productive miracles to meet an unprecedented situation.

12. Government agencies have been putting on the screws to hold down prices on a "voluntary" basis. This is no fun for the man who misses the chance for a fat profit, but the cooler heads of business accept it as a wise and necessary check on the inflationary dangers of a sellers' market.

13. Ordinary production and selling of peace-time goods will continue until it interferes with the defense effort. When such interferences arise defense production will get the right of way.

14. Business prudence will stock up for essential needs; business patriotism will avoid any hoarding that might embarass the defense program.

The foregoing makes no reference to the duties of the power engineer in the narrow sense. We are addressing the POWER reader mainly as a citizen and as a man of industry who must gear his thinking to industry's defense job. As far as the power services are concerned, he will understand that these must always be ready to carry any defense load that may be thrown on his plant.

He will also see that he must be ready to cut corners and sacrifice perfection in layout and equipment wherever necessary to get dependable capacity quickly. For the months immediately ahead the hour glass must replace the dollar sign as the symbol of engineering efficiency—for this is a war against time.

Basic Facts on Wood Burning

Intelligent handling and burning of wood requires knowing how it is made up, the all-important influence of moisture, and something of the 3-stage combustion process. L E Webber, Engineering Experiment Station, University of New Hampshire, gives a concise statement of the basic facts

▶ FROM PREHISTORIC TIMES until about 100 years ago, wood formed man's principal source of fuel; today wood plays a minor but definite part in the fuel picture. Both bark and wood, when they appear as waste from lumbering or industrial processes, can be effectively handled and burned to produce cheap steam. However, published information on the combustion of these and other waste fuels is scattered and not too complete. This article rounds up, in convenient and usable form, the basic facts about wood as a fuel; a future article will go into handling and burning equipment for waste wood.

Wood as used in industrial furnaces may be in the form of cord wood, slabs, edgings, bark, sawdust, and shavings. Usually, several of these are used together, particularly since the majority of plants burning wood as a fuel use only waste from woodworking or other manufacturing operations. Only about 40% of the wood from the trees cut in our forests reaches the consumer in finished products.

Types of Wood Waste

An average of 30 to 50% of the lumber delivered to the mills is waste, available for fuel. The percentage and character of this waste depends primarily on whether the mill is of the "rough" or "finishing" type. Waste from finish mills runs about 25–40% of the lumber processed. It contains a smaller percentage of moisture than waste from rough mills and is usually finer in composition, containing less bark and foreign material (sand).

In some installations, a "hog" chops all of the fuel to a fixed maximum size. The term "hog fuel" is applied to this material. Unfortunately, the term has been loosely used in reference to sawdust, shavings and bark. To be technically correct, hog fuel should include only wood which has been cut up in one of the four types of hogs. Typical hogs consist of: (1) steel disks to which knives are attached, similar to the chipper used to prepare wood for paper-mill digesters, (2) two concentric cones bearing knives and revolving in a conical housing, (3) a cylinder fitted with a row of knives and revolving in a cylindrical housing, and (4) "hammer hogs" in which the wood is broken by the impact of hammers against anvils.

Dull knives in hogs of the knife type tend to shred the wood rather than cut it. Wood which has been shredded becomes a liability; long stringy pieces can clog mechanical fuel feeders and often do much to cause "arching" or "bridging" of the fuel in the gravity feed chutes from the bin, and in the bin itself.

The term "unit" of hogged fuel designates a quantity of 200 cu ft of the material. This is the approximate amount which will be made by hogging one cord (128 cu ft) of wood. It should be pointed out that this term is not entirely satisfactory in that the weight of a unit may vary from 2500 to 5000 lb, depending on the moisture content and the manner in which it is packed down.

Water Absorbent

Wood belongs to that class of materials known as hygroscopic. This means that originally well-dried hogged fuel will absorb water from the air with which it is in contact and attain a greater weight than it had originally. The amount of moisture absorbed depends on the temperature and humidity of the air.

CHEMICAL COMPOSITION OF DRY WOODS

Species	*Carbon, %*	*Hydrogen, %*	*Nitrogen, %*	*Oxygen, %*	*Ash, %*	*Heating Value, Btu per lb*
Oak	50.16	6.02	0.09	43.36	0.37	8,316
Ash	49.18	6.27	0.07	43.91	0.57	8,480
Elm	48.99	6.20	0.06	44.25	0.50	8,510
Beech	49.06	6.11	0.09	44.17	0.57	8,591
Birch	48.88	6.06	0.10	44.67	0.29	8,586
Fir	50.36	5.92	0.05	43.49	0.28	9,063
Pine	50.31	6.20	0.04	43.08	0.37	9,153
Average	49.56	6.11	0.07	43.83	0.42	8,671

(*Based on data by Gottlieb, Mark's MECHANICAL ENGINEER'S HANDBOOK*)

FLUE-GAS ANALYSES FOR COMPLETE COMBUSTION OF WOOD

(Average Gottlieb analysis)

	Perfect Combustion (Per cent by volume of dry products)	*Varying Amounts of Excess Air* (Per cent by volume of dry products)				
		20%	*40%*	*60%*	*80%*	*100%*
CO_2	20.1	16.8	14.4	12.5	11.2	10.0
O_2	0.0	3.6	6.1	8.0	9.5	10.6
N_2	79.9	79.6	79.5	79.5	79.3	79.4
	100.0	100.0	100.0	100.0	100.0	100.0

There is no great variation in the composition of woods generally encountered in industrial plants. The data (by Gottlieb) appearing in the table give the chemical constituents of several species. The major variation occurs in moisture content. This factor depends on the methods of handling the lumber and the nature of the mill or process from which the waste comes. Finish mills use air-dried or kiln-dried lumber. Air-dried wood seldom contains less than 12% moisture. Kiln-dried lumber sometimes contains as little as 1 or 2% moisture but the average runs about 5–7%. Rough mills may produce waste of almost any moisture content but the average is about 30–50%, which is also about the average range for bark. Waste from logs floated to the mill or kept in water storage often contains as much as 70% moisture.

Moisture content is usually determined by the weight method; the required apparatus includes a balance sensitive to 0.01 gram, and a drying oven. A sample of the wood or wood-waste is first weighed on the balance and then dried to a constant weight in the oven, at 212–225 F. The percent of moisture in the sample is found by dividing the loss in weight by the original weight of the sample, and multiplying by 100.

Heat Content

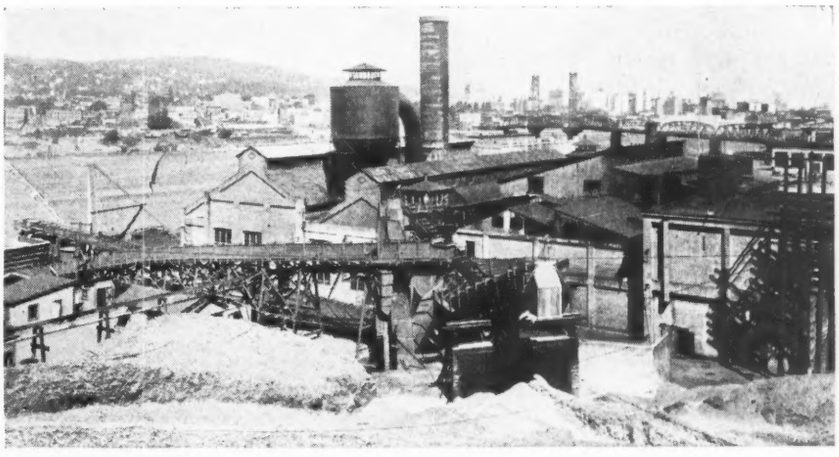
Moisture in wood markedly decreases the heat content per lb of fuel delivered to the furnace. It will be noted in the table that the average heat content is 8671 Btu per lb of *dry* wood. If we compare one lb of dry fuel having this average heat content with a lb of the same fuel which is 50% moisture, it is easy to see that the latter has only 50% of 8671 Btu per lb, or *half* the heat content since only *half* is wood. Further, each lb of water in the fuel must be evaporated in the furnace, and superheated to the temperature of the flue gas. Part of the heat from the burning fuel goes to carry out this unavoidable process.

Chart 1 shows the effect of moisture content on the heat actually available for useful purposes, such as steam raising. These figures assume that the wood enters the furnace at 60 F, that heating value of dry fuel is 8671 Btu per lb, and that flue gas leaves the furnace at a temperature of 550 F. Note that this chart is based on wood fuel having a heating value, *dry*, of 8671 Btu per lb. However, this chart can be used for any specific type of wood, if the heating value, dry, is known.

Suppose we want to find the actual heat available per lb when burning oak having a heating value, dry, of 8316 Btu, and having a moisture content of 10%. We locate the point corresponding to 8316 Btu on the vertical scale and through this point draw a line parallel to the one already shown. The Btu per lb available for useful work can be found at the intersection of this new line and the 10% moisture line.

Combustion of wood takes place in three steps. First, moisture evaporates, then volatile matter is distilled off. The volatile matter bursts into flame and burns, if mixed with air and heated to about 1100 F. In the third and final step the fixed carbon burns. There is no clear-cut dividing line between these various steps; each step overlaps and is overlapped by the others.

The first two steps in wood burning *absorb* heat from the furnace; evaporation of a lb of moisture requires about 1000 Btu while the distillation of one lb of volatile matter absorbs about 200 Btu. Since about 80% of the dry wood is volatile matter, and less than 20% is fixed carbon, the greater part of the heat liberated in the furnace comes from burning the volatiles and only a small part from combustion of the fixed carbon. It can be seen that incomplete combustion of the volatile matter can be one of the greatest losses of efficiency. Incomplete combustion may result from lack of air or, more probably, from poor mixing of air and products distilled from the wood.



Hogged-fuel pile outside Pacific-Coast power plant

Speed of Combustion

The speed with which complete combustion of wood takes place depends on several factors, the most important of which is particle size. Consider the burning of one large piece of wood. Moisture on and near the surface of the piece is first dried out by the heat of the surrounding gas and by heat reflected from the brickwork. Distillation of volatiles then occurs on the surface, after which the fixed carbon starts to burn. As wood is a poor conductor of heat, all three steps may be carried out on the outside of a large piece while the inside is still relatively cool. Such a condition develops strains in the wood which are released by cracking, with the familiar loud reports. Ash will form over the surface of the wood and will effectively stop further combustion unless removed by air or mechanical means.

There are three general methods of burning wood and wood waste: (1) in suspension, (2) in piles on a flat grate, and (3) in a moving fuel bed on an inclined grate. Suspension burning requires dry fine material such as sawdust and shavings from finishing mills or the product of a fine-cutting hog. In suspension burning, the sequence of burning stages described above occurs almost instantaneously. In most installations of this kind, some larger particles fall to the furnace floor without burning completely; these burn there more or less in the manner of wood burned on a flat grate.

Burning wet wood waste in the form of piles on flat grates is much slower than suspension burning. The outer pieces first dry out, principally by the heat reflected from the surrounding brickwork. As combustion progresses, the pieces tend to roll to the bottom of the pile, exposing new surfaces to the heat. A glowing mass of carbon surrounds the bottom of the pile. Oxygen in the air coming in contact with this glowing carbon will form CO_2; however, if this CO_2 comes in contact with more glowing carbon in its passage through the pile, it will be reduced to CO.

Henry Kreisinger's experiments with

lignite char show that all of the oxygen supplied through the grate is used up 1.5 in. from the grate and that practically all of the CO_2 is reduced to CO in the bed above the 1.5 in. If we assume that a similar condition exists with wood char we come to the apparent conclusion that admitting more air through the grate will not help the condition of incomplete combustion; rather it adds to the problem as a whole by increasing the rate of gasification of glowing carbon.

Air for Combustion

Thus, if complete combustion is to be obtained, it can be seen that air must be supplied over and around the fuel pile at a velocity sufficient to mix it well with CO coming from the glowing char and with volatile matter from the distilling wood. Kreisinger suggests that as much as 90% of the air supplied to the furnace should be supplied over and around the fuel pile. In most cases practical considerations reduce this figure considerably.

The inclined-grate method of burning attempts to segregate the three steps of combustion; first the fuel dries on an inclined refractory hearth where it receives direct radiation from the furnace arch, then it slowly slides to an intermediate stationary grate section where distillation occurs and then to a section equipped with manually operated pushers, where the carbon burns. Air is admitted under the intermediate and final grate sections and at high velocity through the nose of the bridgewall. The slopes of the three grate sections are determined by the angles of repose of the fuel in its three states.

In the burning of wood, as with other fuels, an Orsat apparatus can be used to determine the completeness of combustion. The *complete* Orsat analysis should be made since % CO_2 is not an exact measure of the completeness of combustion. Presence of CO in the flue gas indicates considerable loss in potential heating value of the fuel. If perfect combination of wood (with an average analysis as shown in the table) could be obtained, the flue-gas analysis would show: CO_2, 20.1%; O_2, 0.0%; CO, 0.0%; and N_2 (by difference) 79.9%.

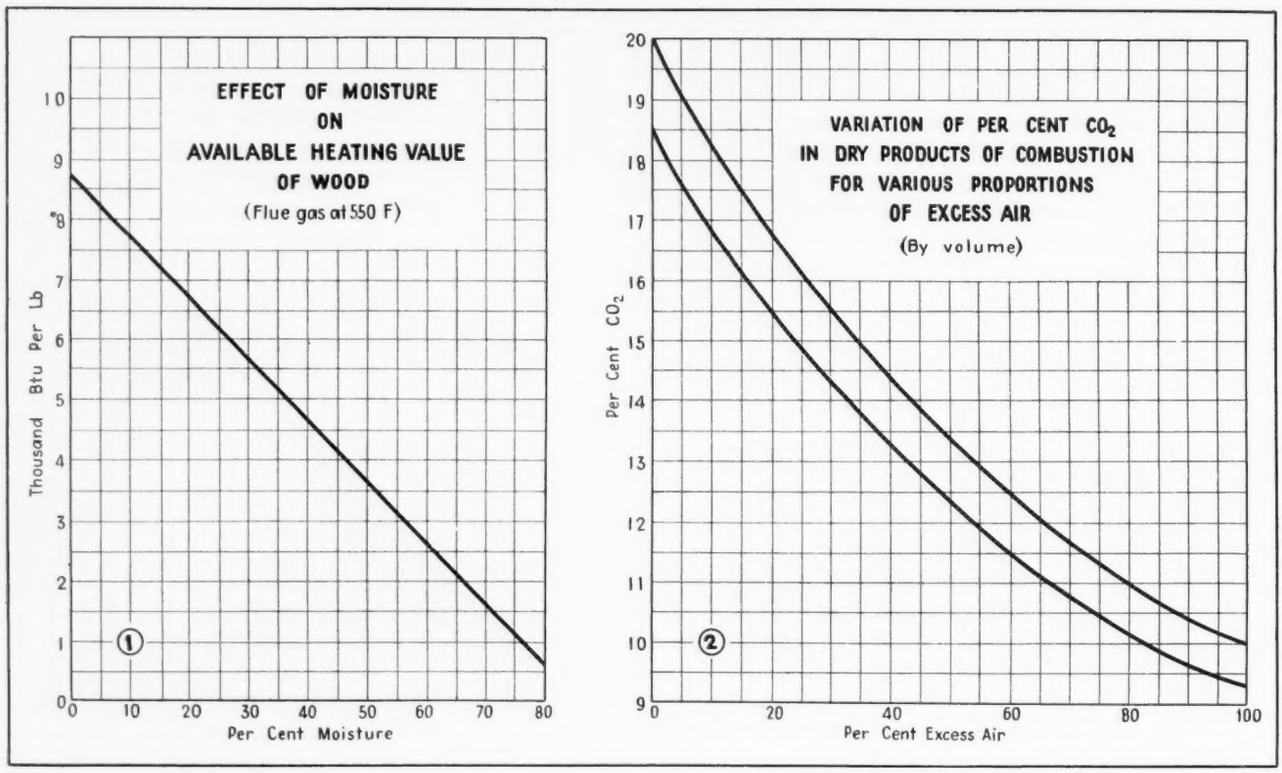
However, to obtain complete combustion in industrial furnaces it is necessary to supply some excess air, which causes the flue-gas analysis to vary from that for theoretically perfect combustion. Chart 2 shows how CO_2, as measured by the Orsat apparatus, varies with the amount of excess air supplied to the furnace. The line for wood is based on a fuel having the characteristics of the average given in the table, and the line for coal, for rough comparison, is based on an eastern semi-bituminous coal having the following analysis:

Carbon	83.52%
Hydrogen	4.89
Nitrogen	1.26
Oxygen	5.66
Sulphur	0.68
Ash	3.99

Chart 2 shows that for complete combustion of the wood, the CO_2 in the flue-gas, as measured by Orsat analysis, varies from 20.1 to 10% depending on the amount of excess air supplied. It should be noted that in every case on the curve, combustion is *complete*, but, of course, combustion is not most efficient at every point. Some care must be exercised in selecting the amount of excess air supplied. Resinous woods, such as pine, will smoke more readily than others. This means that the per cent CO_2 carried cannot be as high as for other woods which do not need so much excess air to avoid smoking.

Check CO and CO_2

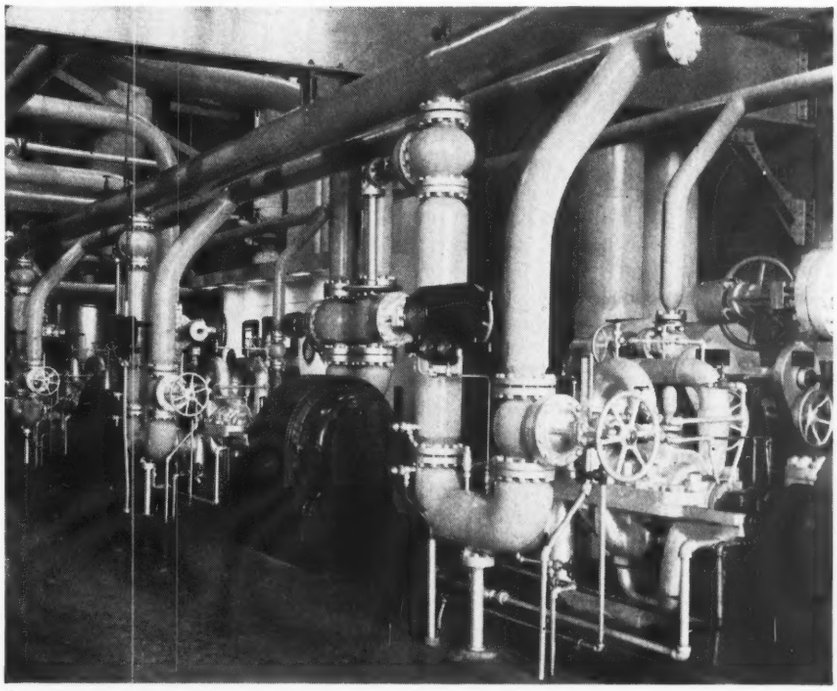
Use of a chart such as No. 2 requires a particularly careful check on CO when making the analysis, to insure that combustion is complete. A high CO_2 reading does not necessarily mean that combustion is efficient; it may mean that air supply is insufficient or improperly introduced into the furnace to insure good mixing. Making the complete analysis checks these possibilities. The second part of the table indicates the range of values to be expected in the complete flue-gas analysis. If air is introduced into the furnace in such a manner that it is well mixed with the volatile matter and CO, the percent excess air will be decreased and a higher CO_2 reading will result, without CO.



High-Pressure Boiler-Feed Pumps—I

Severe requirements of pumping high-temperature water against high pressure not only demand best possible design for most efficient utilization of pumping power, but also proper suction conditions for pumping at a chosen suction temperature

By IGOR J KARASSIK
Application Engineer
Worthington Pump & Machinery Corp



3550-rpm, 305-F, 700-gpm centrifugal feed pumps at Cincinnati Gas & Electric Co

► THE SEVERITY OF MODERN REQUIREMENTS has introduced new problems not only from the point of view of design and construction of boiler-feed pumps, but also from that of application and operation of all the equipment in a steam power plant. Some 20 or 30 years ago, feedwater temperatures in excess of 212 F and pressures over 250 lb were rarely encountered. The modern centrifugal boiler-feed pump is called upon to handle feedwater at temperatures anywhere from 200 to 500 F and pressures up to 3000 lb, depending on the type of installation and the particular feedwater cycle selected by the power-plant designer.

The latter has a choice between two different types of boiler-feed systems insofar as location of the pump in the feed cycle is concerned. The first is based on pumping the feedwater directly from the deaerating heater up to the full required discharge pressure, the feedwater then passing through closed heaters on its way to the boiler.

Two Pumps in Series

The second system involves using two separate boiler-feed pumps operating in series; the closed heaters are between these two pumps. This last system may be chosen in order to (1) reduce the initial cost of the closed heaters, (2) retain existing pumps in the case of a topping unit, (3) meet some special requirements for the slower speed of 1750 rpm, such as the use of wound-rotor motor drive, which would otherwise require as many as 12 stages in a single pump casing.

However, both mechanical and economic advantages result from the use of the single-pump system. A boiler-feed pump, which overcomes the entire head from the deaerating heater to the boiler-feed regulating valve, conserves floor space, reduces the number of stuffing boxes to be packed, eliminates high-pressure and high-temperature stuffing boxes and saves power by handling colder water. This last saving is of an appreciable magnitude, since the power required to deliver a certain weight of water against a given pressure is inversely proportional to the specific gravity of the water. Thus, for instance, a pump handling 400-F water will consume 12% more power than at 212 F.

In addition, the construction of a centrifugal pump is rendered more complex by the necessity of designing stuffing boxes that will perform satisfactorily under the high suction pressures and temperatures to which they are subjected. A range is ultimately reached which precludes the possibility of packing the stuffing boxes without the use of pressure-reducing labyrinths. These are bled back to some region of lower pressure in the feed cycle in order to reduce the stuffing-box pressure. The amount of feedwater bled back through the labyrinths must be handled by the primary pump in addition to the normal capacity of the system, involving a certain additional expenditure of power.

In order to illustrate the difference in power consumption resulting from the two systems, a typical example is presented in Fig. 1. It is assumed that the secondary feed pump of the second system is fitted with pressure-reducing labyrinths, the bleed-off capacity being 3% of the full-load capacity. The water horsepower to be developed by the single pump is 1088, while the 2-pump arrangement must develop 1204 hp, a difference of nearly 11%. Assuming an efficiency of 70% for all the pumps, the second system will require 165 more brake-horsepower at full load.

For a complete evaluation of the operating costs of the two systems, a comparison must be carried out over

the full load range, with a reasonably accurate knowledge of operating hours at various loads. In this connection, it is important to bring out the fact that the percentage of power increment of the second system over the first increases at part loads, because the quantity of labyrinth bleed-off is the same.

The wide range of temperatures in which boiler-feed pumps are required to operate makes it imperative to consider the effect of feedwater temperature on the pump construction and on the choice of materials for the various pump parts. This is such an important factor in maintenance costs and ultimate life of the equipment that the proper selection of better materials for severe-service conditions involves relatively little additional cost in comparison with the betterment in operation.

The choice between cast iron, cast steel or forged steel for the pump casing material is basically dictated by mechanical considerations, and specifically by the requirements imposed by the pressure to which the casing is subjected, as well as by considerations of relative resistance to erosion and lack of porosity. Inasmuch as steel is generally used for pressures over 1000 lb, temperature conditions need not enter into the choice of material for this range of pressures. For the lower range, however, even though cast iron may prove to be quite satisfactory on the basis of strength alone, cast steel should be seriously considered whenever the temperature of the feedwater exceeds 300 F, and is definitely required for temperatures above 350 F.

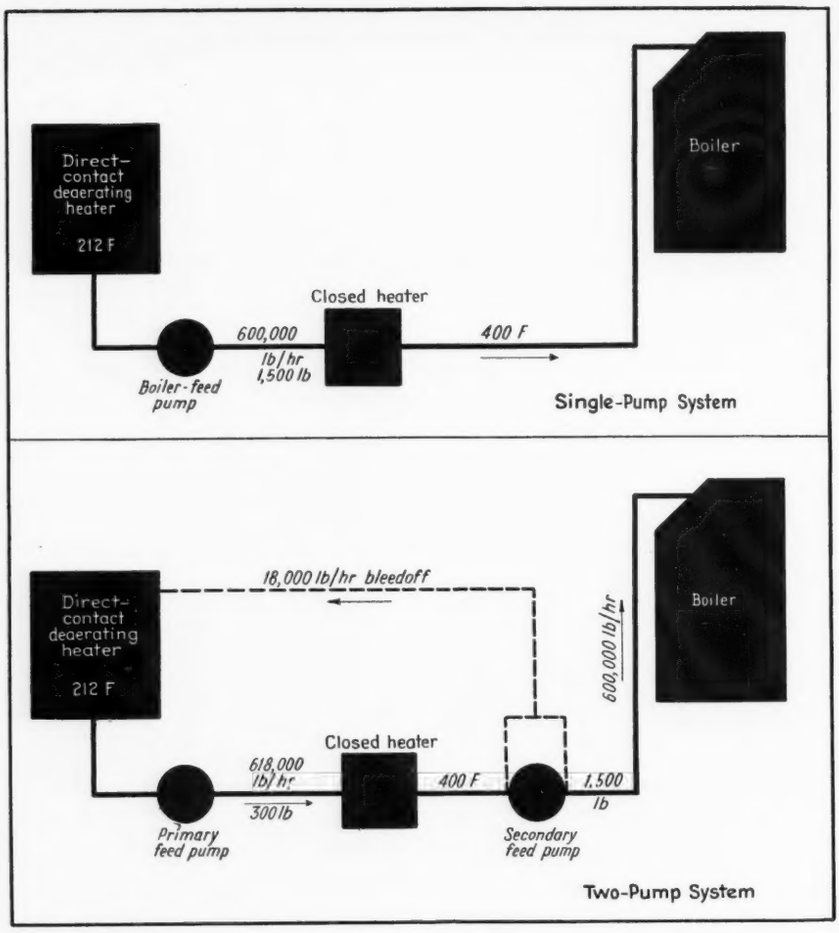


Fig. 1—High-pressure pumping can be accomplished in a single step at low temperature or by a 2-pump setup in which the high-temperature pump may require a leakoff

Choice of Materials

In the question of the choice of materials for the boiler-feed-pump fittings, it is safe to say that, if not for all feedwater temperatures, then at least for over 250 F, the use of materials having a coefficient of expansion approximately equal to that of the shaft and of the casing is highly desirable. Thus, from strictly mechanical considerations, steel or stainless-steel fittings are preferable to bronze, because the coefficient of thermal expansion of bronze is about 40% greater than that of steel. As it is impossible to shrink bronze impellers on a steel shaft, the clearance between the shaft and the impeller hubs will increase as the pump is brought up to operating temperature, introducing the possibility of leakage between shaft and impellers.

The longitudinal expansion of the rotor assembly has an even more marked effect on the condition of the pump. Inasmuch as the bronze assembly will expand to a greater degree than the steel shaft, the impeller hubs will be "crushed" to the extent of the difference in expansion. Since this cannot take place uniformly and evenly, severe moments will be exerted on the shaft, with consequent bowing of the latter. These possibilities are obviously removed when the pump fittings are such that inequality of expansion between the shaft and the rotor assembly does not exist.

For operation at high temperatures, the pump casing should be supported as near to the horizontal centerline as possible. Such a construction will prevent excessive strains due to temperature differentials which might otherwise seriously disturb the alignment of the unit. Certain pump manufacturers, as a matter of fact, have standardized on centerline casing support for boiler-feed pumps, regardless of the operating temperature.

Stuffing-box design is likewise intimately connected with the temperature of the feedwater. Unfortunately, the art of stuffing-box design has not yet reached the status of an exact mathematical science, but is based on empirical knowledge, and therefore differs greatly with the various pump manufacturers. A store of valuable data is slowly being gathered, however, and there is hope of a more rational analysis of stuffing-box performance in the near future.

Experience has shown that adverse conditions accumulate until a certain combination of pressure, temperature and other adjunct factors is reached when a stuffing box can no longer be packed successfully. It then becomes necessary to incorporate pressure-reducing labyrinths ahead of the stuffing box proper. It is of course impossible to set exact limiting conditions for the use of these labyrinths, as they depend on the diameter of the boxes, the operating speed and the relative excellence of the cooling system, as well as on the prevailing pressure and temperature.

However, we know from experience that, with proper cooling, it is possible to pack satisfactorily a 4-in. stuffing box operating at 3600 rpm, when subjected to 400-lb pressure at 400 F, provided the pump is perfectly balanced and operates without vibration at any load. Operation of a centrifugal

pump at abnormally light flows, as occurs frequently in some stations, increases shaft vibration and is therefore detrimental to good stuffing-box performance.

Fig. 2 illustrates qualitatively the effect of temperature and pressure on a factor which is assumed to represent stuffing-box wear. No values are given, as the curves are indicative of the relation only, and are intended more as a suggestion for the recording of experimental results than as an actual description of facts already determined.

While the minimum net positive suction head (in excess of vapor pressure) should theoretically be independent of the feedwater temperature, the latter has an important bearing on satisfactory suction conditions in practice. When a boiler-feed pump takes its suction from a direct-contact heater at a relatively high temperature, it is recommended that a safety factor be provided in establishing the required submergence.

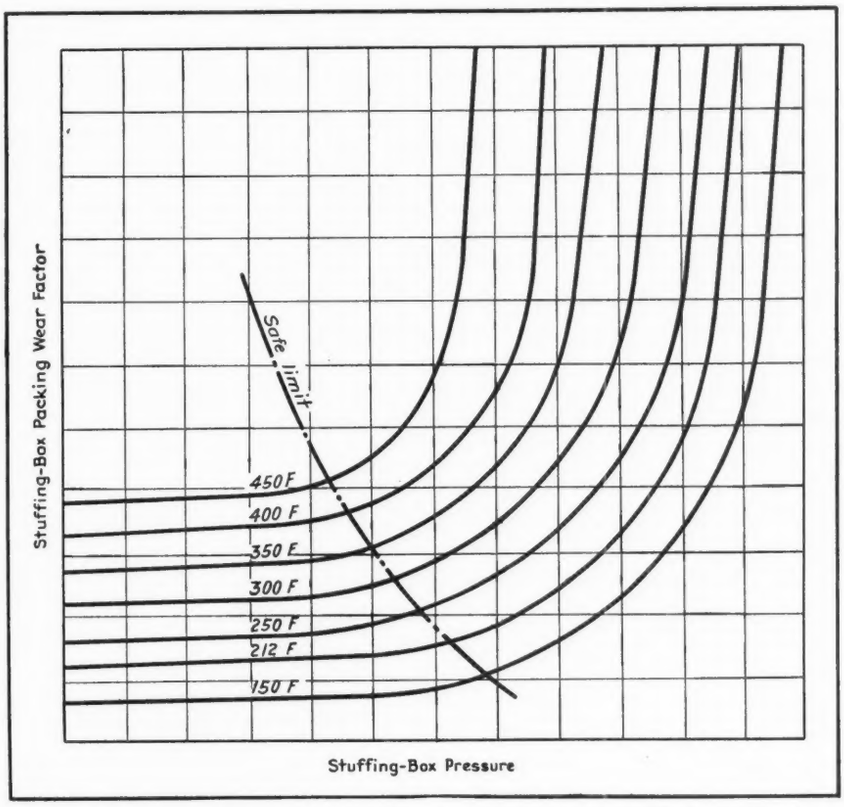


Fig. 2—Pressure and temperature affect the safe limits of stuffing-box operation

This safety margin compensates in part for possible fluctuations in the heater pressures and for the time lag between a sudden reduction of pressure in the heater and the ultimate reduction of temperature at the pump suction. This effect is more accentuated in the higher temperature range because of the more rapid increase in vapor pressure for a given increase in temperature. Thus, for example, a 12-ft differential between the suction pressure and the vapor pressure corresponds to a margin over flashing of 15 degrees at 212 F, and of only 1.6 degrees at 400 F.

Above 300 F

However, a boiler-feed pump operating at temperatures above 300 F does not usually take its suction from a direct-contact heater, but is supplied by some type of primary, or booster, pump. As a result, the suction pressure of the main feed pump corresponds to the discharge pressure of the primary pump (less line losses) and no difficulty is experienced in providing a margin from 50 to 200 lb over the vapor pressure.

In general, while feedwater temperature should be given all due attention in analyzing the suction conditions, the desire to provide proper and safe operating conditions for the boiler-feed pump should not lead to the imposition of unnecessary and impractical limitations on associated equipment of the feedwater system.

[Editor's Note: This article has been condensed from a paper awarded first prize by the Hydraulic Institute. A second article concerning the effect of temperature rise in boiler-feed pumps will appear in April POWER.]

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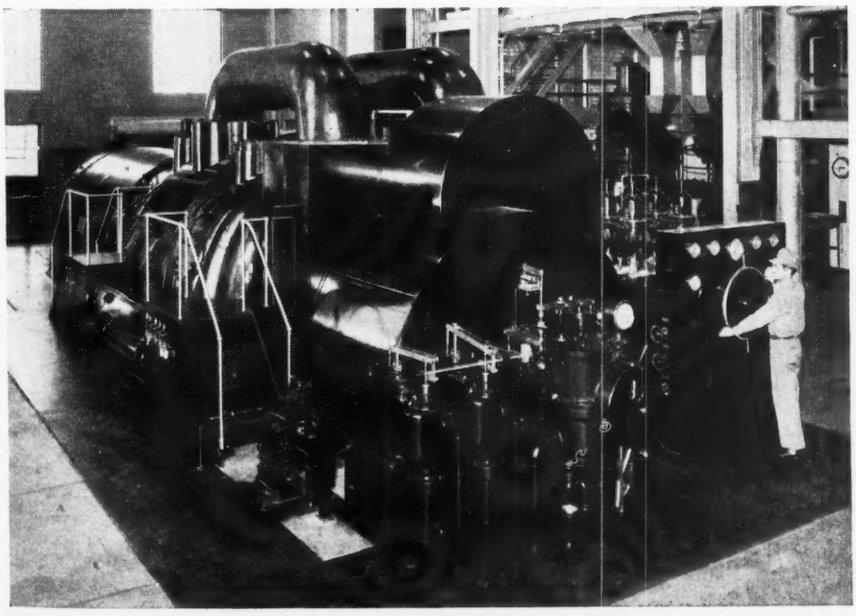
First of Two Hutsonville Units



► A DUPLICATE OF THIS 25,000-kw, 3600-rpm, tandem-compound, Allis-Chalmers turbine-generator at Hutsonville, Ill., now under construction for Central Illinois Public Service Co, will go into operation late this spring. Each unit takes steam at 650 lb, 835 F from two 150,000-lb-per-hr, pulverized-fuel-fired boilers (Combustion Engineering Co), partly visible in the background. Sargent & Lundy, Chicago, are consulting engineers for the project.

Evaluating Corrosion Resistance of Modern Turbine Oils

A good turbine oil should resist oxidation, protect steel against rusting, separate from water readily and have good load-carrying properties. Laboratory tests indicate that rust-inhibiting qualities can be imparted to long-life non-sludging oil

By N B WILSON, G H VON FUCHS, and K R EDLUND
Shell Oil Co, Inc, Research Laboratories, Wood River, Ill.

▶ EARLY TURBINES WERE OPERATED at low steam pressures and temperatures. Dimensions were small and lubrication (ring-sleeve) simple. No specially refined oils were needed; none were available.

Modern large turbines with forced lubrication of shaft and thrust bearings require lubricating oil to act as a coolant and as a hydraulic transfer medium to actuate the governor. In some instances the same oil also lubricates high-speed gears. These added services, plus the increase in size of the turbine itself at generally higher rotative speeds, have steadily increased demands on the lubricant.

Earlier, less highly refined oils were unstable, that is, they formed deterioration products which caused emulsification with water, foaming and deposition of sludge. At first the effort to improve turbine oils was mainly directed at reduction of sludging tendencies. It was soon recognized, however, that oil-soluble deterioration products (organic acids, etc) were equally harmful, since they increased the tendency of the oil to emulsify with water.

Attention was therefore directed toward oxidation characteristics to the exclusion of other considerations such as ability to wet the metal surfaces. The latter quality is important in preventing rust on turbine and governor parts when water is present.

Wetting Properties

Earlier turbine oils either contained compounds which promoted formation of an adherent film of oil or formed similar compounds quickly through oxidation. Modern refining methods (such as solvent extraction) produced improvements in sludging and emulsification characteristics but removed desirable wetting agents responsible for anti-rusting quality. The oils became more stable, but were inferior to the less highly refined oils in rust prevention.

Corrosion in turbine-oil circulating systems has been observed for many years. Rusting of sensitive governor parts, however, has become a serious problem only within the last few years[1] because of more intricate turbine and governor designs. Turbine operators, oil refiners and turbine builders are all aware of the importance of anti-rust properties as well as oxidation stability. ASTM has committees studying the matter.

The view has been widely held that it is impossible to produce a single oil which provides positive rust prevention, is highly stable toward oxidation, and

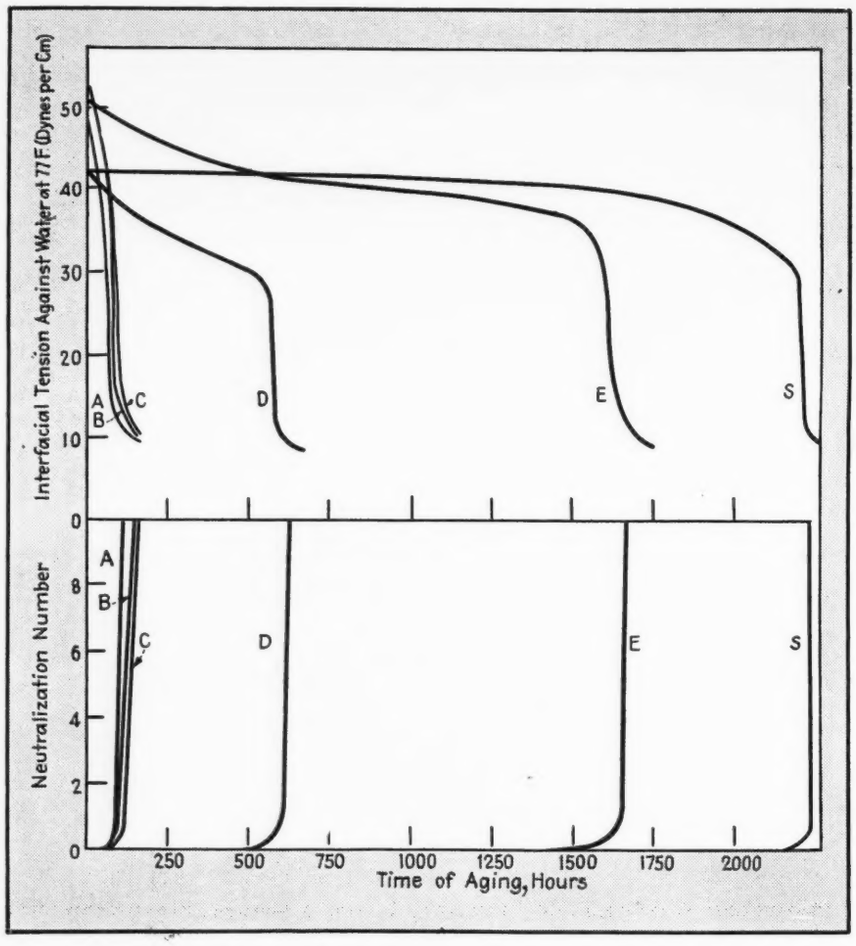


Fig. 1—Turbine oils differ greatly in potential service life as evaluated by this laboratory test which measures oxidation stability of oil under accelerated conditions

also meets the normal requirements of a turbine lubricant. Recent research indicates that the three requirements can be combined in a single oil and laboratory tests are here presented on a lubricant recently made commercially available that compares favorably with other turbine oils in lubricating properties and stability, but has anti-rust properties as well.

Tests that check the actual properties of a lubricant in service determine the proper time for changing an oil fill. Besides these, accelerated tests are required to enable prediction, within a reasonable time in the laboratory, of the life expectancy (as determined by oxidation stability) and anti-rusting qualities to permit intelligent selection of satisfactory turbine oil. We have applied the usual standard test procedures to several oils, and devised certain new methods in collaboration with turbine manufacturers and operators.

Instantaneous Properties

Interfacial tension against water is a function of polar or hydrophilic molecular groupings present in an oil and bears a relation to its emulsifying tendencies. It may be conveniently measured by the pull-ring method employing the DuNouy tensiometer.

New, highly refined oils have interfacial tensions above 40 dynes per cm but the formation of oxidation products or contamination with used oil sharply reduces the value. This test is the only practical means of determining early stages of oxidation (down to 30 dynes per cm) during which mere traces of impurities are present.

Neutralization number (ASTM-D188-27T, Method A) measures the oil-soluble acid content expressed in milligrams of equivalent KOH per gram of oil. Since well-refined turbine oils have no measurable neutralization number (less than 0.05), any free acids found are a sign of oil deterioration or contamination. The acidic oxidation products are emulsifying agents and seriously affect interfacial tension.

When interfacial tension drops below 30, measurable quantities of acids are usually present. Certain organic acids attack copper and iron, forming oil-soluble soaps. These soaps, in addition to being promoters of emulsification, also act as powerful oxidation catalysts.

Since various types of acids are formed under different conditions of operation and oil composition, no strict limit on neutralization number can be set. Well-refined oils should not exceed a neutralization number of 1 in service. At this point interfacial tension has become very low, 15 or less, and permanent emulsions often tend to form.

Interfacial tension and neutralization number are by themselves sufficient to characterize the condition of a turbine oil in service. Certain additional tests, however, often provide useful information.

Saponification number, expressed in the same units as neutralization number, includes esters, soaps and some potential acids (peroxides) in addition to the free acids determined by the neutralization number. The saponification number is thus always larger than the neutralization number (often five to ten times) and measures a large part of the oxidation products present in the oil. The determination, however, is more elaborate and time consuming than that of the neutralization number.

A sharp increase in saponification number is an indication of approaching oil breakdown and sludge formation. The saponification number of sludge is very high.

The determination of *sludge content* (naphtha-insoluble) has lost much of its significance for modern non-sludging turbine oils. The oxidation products in these oils remain in solution long after the oil has become unfit for service.

Sludge deposits in neglected turbine systems, however, represent a serious problem. Unless such deposits are completely removed, they reduce drastically the life of the subsequent oil fill.

Viscosity of the lighter grades of turbine oil is measured and specified at 100 F while that of marine oils is specified at 130 F. Whereas direct-connected turbines require a low-viscosity oil, a compromise must be reached for geared units in which the oil is called upon to lubricate both bearings and gears. In these units a single oil may be too heavy for the bearings, causing loss of power due to "oil-drag," and yet be not heavy enough for safe lubrication of the gears.

An increase in oil viscosity in service is usually due to an accumulation of oil-soluble oxidation products. It is a forerunner of sludge formation.

Predicting Performance

Turbine oils are expected to withstand continuous operation at moderately elevated temperatures in the presence of air, water and metals without forming sludge or emulsions. Their service conditions are essentially different from those of automotive lubricants and efforts to evaluate turbine oils by commonly accepted test methods carried out at high temperatures have proved singularly unsuccessful.

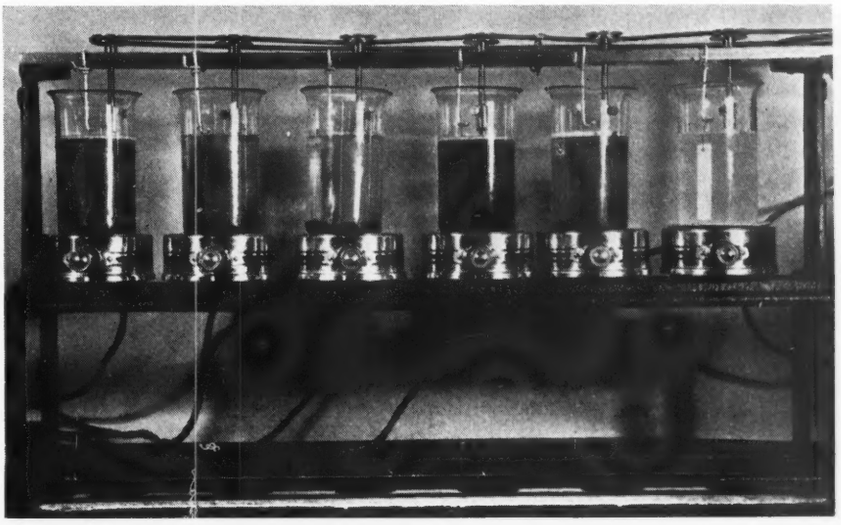


Fig. 2—Test apparatus in which air and water are whipped into turbine oils to hasten corrosive action on metal specimens

The need for a special aging test, taking into account turbine operating conditions, has been recognized for some time. An early test adapted specifically for turbine oils was devised by N E Funk.[2] This test was later modified and other tests devised.[3]

The *turbine-oil stability test* was adapted by our laboratories for predicting useful life expectancy of turbine oils and incorporates the best features of earlier tests.[4] Samples of oil are aged under conditions approaching those met in practice but with deteriorating factors held constant. Sufficient oxygen is supplied to keep the oil saturated and volatile oxidation products, known to accelerate oil breakdown, are retained to an appreciable extent by a reflux condenser. Metallic copper and iron

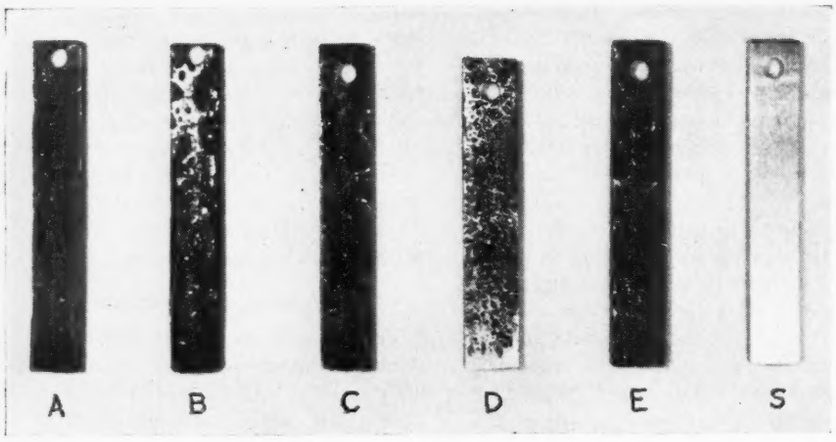


Fig. 3—Rusting test of polished-steel specimens shown after 48-hr exposure to accelerated test of six turbine oils at 167 F

are kept in contact with the oil and water is added. Water has an accelerating effect especially pronounced in the presence of metals. Oil temperature is maintained as high (203-205 F) as is compatible with the presence of liquid water.

Small samples, removed at suitable intervals, are tested for interfacial tension and neutralization number. This test correlates well with practice in rating oils in the same relative order as their known service records. These values are shown plotted against time of aging in Fig. 1. However, because of the wide variation in actual operating conditions, a hard and fast prediction of the life expectancy of a given oil in a given turbine cannot be made on the basis of any laboratory test.

Rusting Test

An anti-rusting test, first devised by W P Kuebler of Westinghouse, calls for suspending a highly polished steel specimen in an oil which is then stirred for a time to insure wetting of the specimen. One percent by volume of distilled water is added and stirring continued eight hours a day for five days. These first tests, which have been confirmed by the authors, revealed that only two commercially available oils at that time (1939) afforded protection against rusting at room temperature.

A modified test complies more nearly with conditions met in operation. The test temperature was raised to 167 F (75 C) and stirring carried on continuously for 48 hours. Rusting proceeded rapidly in all oils that allowed rusting at room temperature. One of the two oils affording good protection at low temperatures was found ineffective at the higher temperature. This oil was also found to allow rusting in actual turbine service. The other oil was not considered acceptable from the standpoint of sludging, foaming and emulsification.

A clear distinction should be drawn between two types of corrosion which result from fundamentally different reactions. One type of rusting, experienced particularly in poorly vented vapor spaces of oil reservoirs and return-oil piping, also occurs occasionally in bearings and on shafts when the turbine is shut down. Rusting of this kind, observed for many years, is caused by vapors from oxidized oil coming in contact, in the presence of moisture, with metal surfaces not normally covered by oil. This type of corrosion is probably best combatted by application of a protective paint.

Rusting that occurs after only a few days of operation with new oil, and is present on surfaces that presumably have been covered by the lubricant is of a quite different character. The new oil can not have formed acids; the rusting is caused by moisture coming in contact with metal surfaces due to incomplete wetting by the oil. Much like the lack of wetting of glass by mercury, the oil is readily displaced by water which causes the rusting. An oil that possesses good wetting qualities protects against this more serious type of attack.

We have since been able to produce a turbine oil on a commercial basis that has satisfactory performance in both stability and anti-rusting tests. Its interfacial tension and neutralization number compared with five other modern highly refined oils are related to aging hours under test in Fig. 1, curve *S*. Its anti-rust characteristics at 75 C under modified rusting test are similarly shown in Fig. 3, specimen *S*.

Deteriorating Factors

Both the consumer and the manufacturer are benefitted if the actual life of a turbine oil in service approaches its reasonable life expectancy. Since poor operating conditions seriously shorten the life of even the best turbine oil, control of factors affecting oil deterioration is of utmost importance.

To combat rusting, some operators have turned to the addition of used oil to new oil fills. While protection against rusting has been attained by this means, the procedure should be avoided because it greatly reduces oil life. Fig. 4 shows that 5% addition of mildly deteriorated used oil to an oil of ordinary stability effects a serious reduction in oil life as indicated by the accelerated tests. Fig. 5 shows that 10-15% the same of used oil added to a highly stable oil can reduce potential oil life as much as 80%.

Turbine oils are often kept in service until the oil has deteriorated to such an extent that it not only has a high neutralization number but also deposits sludge. When the oil is then finally changed, the new oil fill becomes contaminated with old oil and sludge remaining in the system; the actual life of the new oil will then be only a fraction of its life expectancy.

Water, Metal, Heat

Water, entering turbine oiling systems from steam leaks or other causes, has been found, both in laboratory and service, to cause deterioration considerably faster than normal (as high as ten times). Turbines with effective seals and no accidental water leaks often operate for long periods on inferior oils. If, in this case, water suddenly gains access to a highly deteriorated dry oil containing large amounts of oil-soluble oxidation products, emulsification and rapid precipitation of sludge may occur.

The catalytic action of both copper and iron on oxidation of turbine oils is well recognized. The activity of iron is probably much smaller than that of copper per unit surface but the

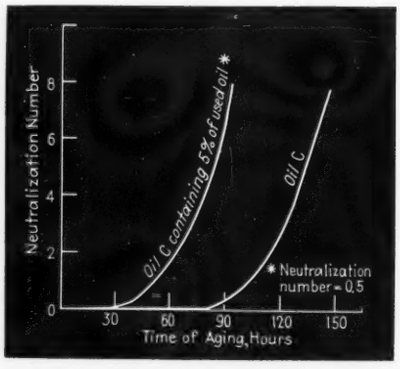


Fig. 4—Mixing used oil with new oil of ordinary stability hastens acid formation

exposed surface area is greater. Since metal catalysis is a function of the ratio of metal surface to oil volume, other factors being equal, an increase in the oil capacity of the system will materially reduce the rate of oil deterioration. A larger oil volume also permits a reduction in the rate of oil circulation and affords a better opportunity for the water to settle out. Reducing water content not only decreases the effect as a promoter of undesirable emulsions but also reduces metal catalysis and rust formation.

The replacement of copper and other catalytic metals by aluminum has been suggested. While some progress in this line is possible, there are several limitations to be considered such as cost and tensile properties and the large number of existing systems containing both iron and copper. The most practical approach to this problem is to select an oil of low susceptibility to metal catalysis and good anti-rusting quality.

Most chemical reactions are accelerated by a rise in temperature. One of the most effective ways to increase the life of an oil in service is to reduce its operating temperature. Steam-turbine parts are relatively hot compared, for example, to hydro units in which most oils last for years without appreciable deterioration. The best turbine oil will last less than a day at 300 F if kept saturated with oxygen in contact with metals.

One factor influencing temperature of oil is the rate of heat transfer through oil-cooler tube walls. Sludge and rust deposits on the oil side and scale or algae on the water side have the net effect of causing a higher average oil temperature. The use of a modern non-sludging, rust-preventing oil will help keep clean at least the oil side of the cooling surfaces.

Oil Maintenance

A number of different methods are employed by operators to keep oil in serviceable condition. These have a marked effect on oil life.

Sweetening is the practice of drawing off some of the used oil periodically and replacing it with fresh oil. The practice originated in times when turbine oils in common usage formed sludge in service which accumulated in the bottom of the settling tank or oil reservoir. Drawing off used oil tended to carry away sludge together with such water and emulsions as were present.

Modern turbine oils do not form sludge during their serviceable life. If an oil is in good condition, it does not require sweetening; on the other hand, if it has deteriorated, sweetening with new oil is of little benefit.[6] Although the neutralization number is reduced in proportion to the ratio of the new oil added, the benefit is temporary and the rate of deterioration is not reduced proportionally. Normally, therefore, the practice of sweetening must be regarded as wasteful.

Centrifuging will greatly accelerate the separation of suspended water, sludge and solid particles. These are impurities which, if given a chance, would settle out spontaneously.

Settling by gravity can take the place of centrifuging if adequate settling and filtering capacity is provided. Since water settles out best if the oil is kept warm, settling tanks are usually placed ahead of oil coolers. It is advisable, however, not to exceed 130 F in the oil settlers to avoid unnecessary oil deterioration. The practice of heating oil in the settlers by built-in electric heaters or high-pressure steam coils to break an emulsion is decidedly harmful in view of the high local temperatures.

Filtering by continuous bypass through cotton bags preceded by settling, is generally satisfactory. An asbestos-leaf pressure-type filter has been found particularly effective in removing colloidal iron oxide.

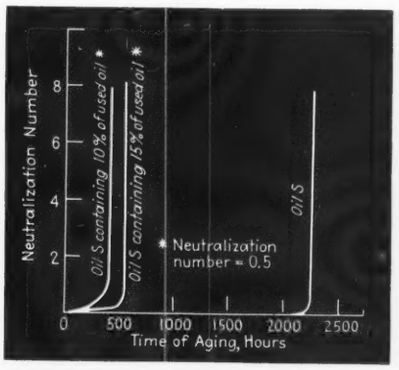


Fig. 5—Effect of 10-15% addition of used oil for rust protection is more pronounced on oil of high oxidation stability

Continuous bypass filtration through clay has been suggested. Turbine oils of high oxygen stability are adversely affected by clay and such filtration must not be applied to these oils.

Washing used turbine oil with hot water to remove oxidation products has been recommended in combination with centrifuging or filtration.

Modern turbine oils of high oxidation stability obviously do not require water washing as long as no oxidation products are present. Such a washing process is justified in some instances where earlier-type oils have undergone relatively rapid deterioration in service. Even for these, water washing can be helpful only during the early part of the oil life; at later stages of deterioration, there is danger of the water forming a permanent emulsion.

If the seals of the turbine leak, hot water is continuously in contact with the oil. Oils last longer in the absence of water, and every effort should be expended to keep water out of the oil, the opposite of any washing procedure.

Venting provision should be made to eliminate air in the system as quickly as possible. In high-speed turbines, a vacuum as high as 20 in. Hg may exist above the shaft in the bearing[8] due to an action that might be compared to a rotary vacuum pump. This vacuum pulls in some air which becomes dissolved in the oil in the pressure area of the bearing under the shaft, often causing foaming. The remaining air may ultimately cause oxidation.

The vented air is often saturated with water vapor, and, if the turbine oil has deteriorated, also with volatile acidic oxidation products. These vapors, if not quickly released, not only accelerate the deterioration of the oil but also in contact with moisture promote rusting in the vapor space of oil tanks, bearing housings, and gear cases.[7] Oil vapors escaping through vents, if condensed, should not be returned to the system under any circumstances.

Oil Control

Turbine oil logs are a decided aid to oil maintenance. In them are recorded data such as the description of turbine or turbines, their location, make, type, size, rpm, steam pressure and temperature, type of service, volume of oil system, temperature of oil entering and leaving bearings during operation, type of oil maintenance equipment, type of oil, date of fill, dates and volumes of makeup oil, hours of service, and analyses of oil samples (interfacial tension, neutralization number, etc). Such logs are valuable to operator and oil manufacturer alike in the analysis of any lubrication problem.

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[1] By M D Baker, West Penn Power Co, Springdale, Pa.

[2] *Ind Eng Chem*, 16, 1080, 1924; also U. S. Patent No. 1,770,735.

[3] "Copper Catalysis Accelerates Turbine Oil Oxidation," Harold Farmer, *Electrical World*, May 20, 1939. Also F A McLean, Pennsylvania Power Co, private communication.

[4] Rogers and Miller, *Ind Eng Chem*, 19, 308, 1927; also B F Hunter, H A Ambrose, and K P Powers, POWER, May, 1939, page 99.

[5] "Steam Turbine Principles and Practice," Terrell Croft, McGraw-Hill, 1940, page 188, Fig. 195.

[6] F C Linn, General Electric Co, Lynn, Mass., private communication.

[7] "Lubrication of General Electric Steam Turbines," C Dantsizen, Annual Meeting of A S M E, New York, December, 1940.

Standard Stairs Aid Safety

Adopting uniform construction will make stairs as safe as practicably possible, according to W Elwood Rossnagel, Safety Engineer for Consolidated Edison Co of New York

► OPERATING STAIRS in power plants, gas works, chemical plants and other special locations that supplement main building stairways ordinarily are not covered by local building codes. Designs recommended herein should not be permitted in any way to conflict with municipal or state requirements.

These standards have been prepared to assist the engineer and draftsman in designing stairs which will be as safe as it is practicable to make them. At the same time, such standards promote uniformity of design.

Maximum Rise

No single flight of stairs should have a total rise of greater than 12 ft without an intermediate landing. The landing should have a length not less than the width of the stairs, and preferably not less than 44 in. Under cramped conditions it may be necessary to reduce the width of the stairs to the absolute minimum, but as even the narrowest standard stair is as safe as a ladder, it is not possible from a safety viewpoint to give any minimum dimension for the width of a stair. However, anything less than 24 in. between railings will be uncomfortable.

The steps should be proportioned to give greatest comfort and to present least danger of tripping when descending. Many building codes require that the steps be so designed that the product of the individual riser and the effective tread (exclusive of the nosing) shall be between 70 and 75. Fig. 1 shows graphically the proper proportions of the steps for stairs at various angles.

On page 72 is a table of stair angles when treads and risers are known, and vice versa. Figures between the two zig-zag lines are ideal stairs. On short stairs it will often prove impossible to obtain the proper proportions, but exceptions are rather few.

In descending a block-type stair, such as occasionally are made of concrete, a man with long feet will first place the ball of his foot on the step, and then, in attempting to lower his heel, he will strike the riser, thus throwing him forward if he is not holding the hand-rail. To reduce this hazard to a minimum, stairs are usually constructed with one tread slightly overlapping the one below, this overlap being known as the "nosing."

On well-built stairs the nosing is usually ¾ in. or more. On improperly proportioned stairs, even those with proper nosings, a man descending is still likely to strike his heel on the riser.

In order not to confuse a person going down stairs, nosings of the treads are made conspicuous. On solid treads

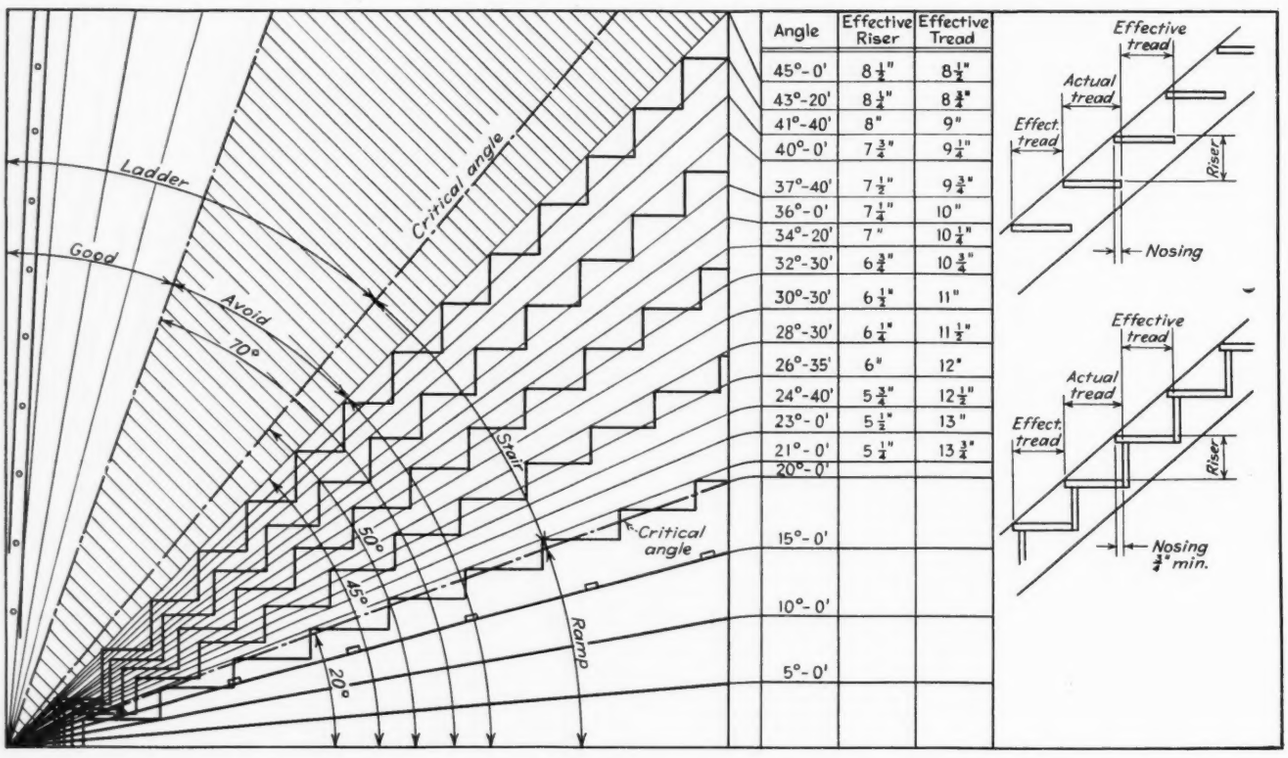


Fig. 1—The angle of rise makes the difference between a ramp, a stair and a ladder

no hazard is presented, but on open-grating treads it is often difficult to differentiate between the steps. This has been recognized by the grating manufacturers most of whom now offer treads having nosing of different construction from the tread proper.

While building codes usually limit ordinary stairs to a much smaller angle, stairs connecting operating platforms are often permitted to reach an angle of 45 deg, and occasionally 50 deg to the horizontal when used by men only. If it is not possible to use a stair at 45- or 50-deg angle, then a standard ladder should be used.

The range between 50 deg. and 70 deg is a cross between a stair and a ladder commonly known as a "ship ladder," which is directly responsible for many accidents and should not be used if it can possibly be avoided. Such ship ladders are usually provided with steps, either flat like a tread or made of two or three rungs close together in a horizontal plane, and with handrails on each side about a foot away from the stringers.

Ship ladders are reasonably safe for ascending, and for descending backwards, but it is impossible to enforce the rule to go down backwards. In descending facing forward it is difficult if not impossible to place the ball of the foot on the step, and as a result there is a tendency to throw a man forward.

Conventional stairs should be connected by horizontal landings and never by "winder" treads, as the depth of the treads at one side is too narrow to afford adequate footing. Likewise circular or winding stairs are not recommended. If their use is imperative, then they should be arranged in a left-hand helix so that the man descending, and keeping to the right, will use the wide portion of the treads.

Surfacing for Treads

All stair treads should have a non-slip surface such as wood, concrete, grating, checkered plate or abrasive metal. If smooth steel plate is used, small buttons or globules of metal should be placed on the surface by an electric welder, these buttons being arranged in diagonal lines not more than 2 in. apart in both directions.

Handrails on stairs and landings should be of the same type as used on platforms. All operating stairs having four or more risers should be provided with handrails, as should all stairs in public places having two or more risers. Stair handrails should be 36 in. high above the middle of the treads, except that in outdoor locations,

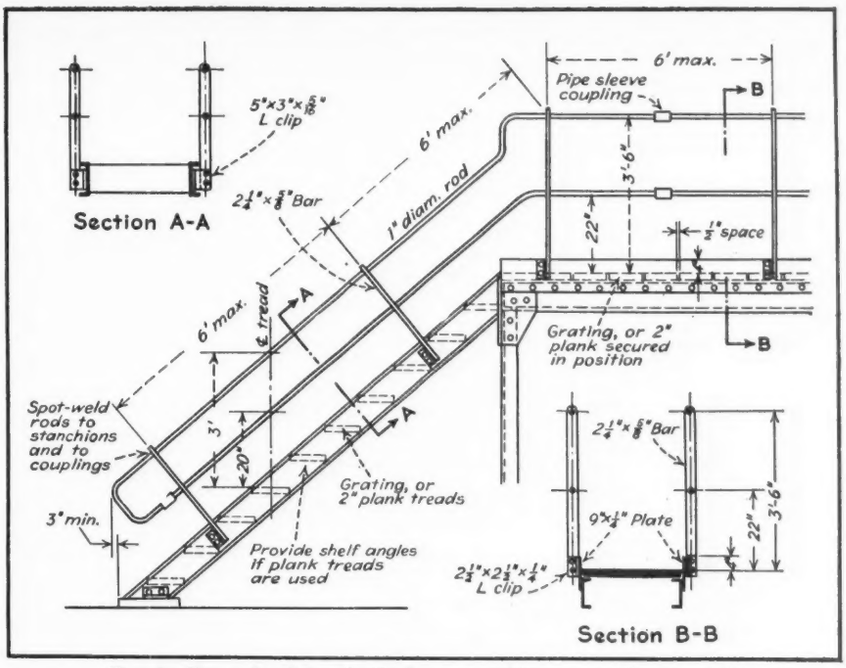


Fig. 2—Bar-and-rod handrails have stanchions at 90-deg to rails

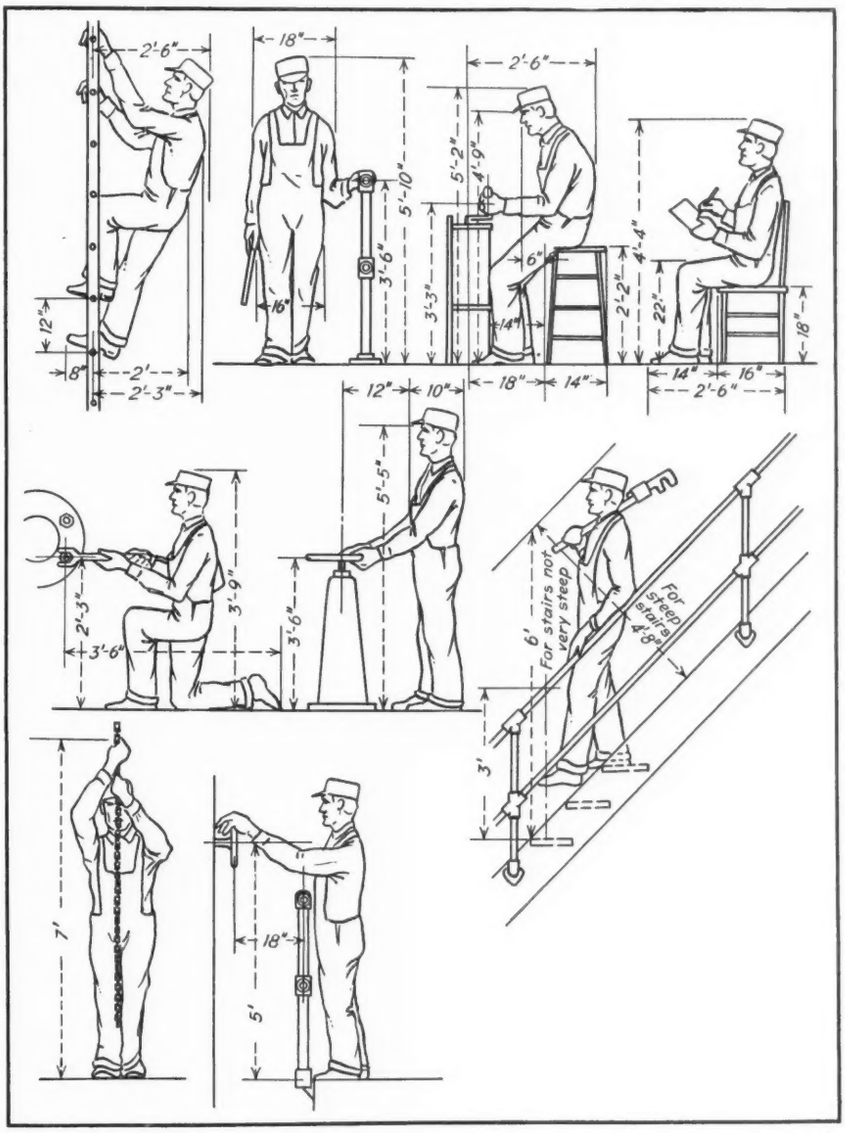


Fig. 3—Typical clearances needed by average man doing everyday power operator's job

TREADS \ RISERS	5	5¼	5½	5¾	6	6¼	6½	6¾	7	7¼	7½	7¾	8	8¼	8½	8¾	9	9¼	9½	9¾	10	10¼	10½	10¾	11	11¼	11½	11¾	12
12	22½	23½	24½	25½	26½	27½	28½	29½	30½	31	32	33	34	34½	35½	36	37	37½	38½	39	40	40½	41	42	42½	43	44	44½	45
11¾	23	24	25	26	27	28	29	30	31	31½	32½	33½	34½	35	36	36½	37½	38	39	39½	40½	41	42	42½	43	43½	44½	45	45½
11½	23½	24½	25½	26½	27½	28½	29½	30½	31½	32	33	34	35	35½	36½	37½	38	39	39½	40½	41	41½	42½	43	43½	44	45	45½	46
11¼	24	25	26	27	28	29	30	31	32	33	33½	34½	35½	36½	37	38	38½	39½	40	41	41½	42½	43	43½	44½	45	46	46½	47
11	24½	25½	26½	27½	28½	29½	30½	31½	32½	33½	34½	35	36	37	37½	38½	39½	40	41	41½	42	43	43½	44½	45	45½	46½	47	47½
10¾	25	26	27	28	29	30	31	32	33	34	35	36	36½	37½	38½	39	40	40½	41½	42	43	43½	44½	45	45½	46½	47	47½	48
10½	25½	26½	27½	28½	29½	31	32	33	33½	34½	35½	36½	37½	38	39	40	40½	41½	42	43	43½	44½	45	45½	46½	47	47½	48	49
10¼	26	27	28	29½	30½	31½	32½	33½	34½	35½	36	37	38	39	39½	40½	41½	42	43	43½	44½	45	45½	46½	47	47½	48½	49	49½
10	26½	27½	29	30	31	32	33	34	35	36	37	38	38½	39½	40½	41	42	42½	43½	44½	45	45½	46½	47	48	48½	49	49½	50
9¾	27	28½	29½	30½	31½	32½	33½	34½	35½	36½	37½	38½	39½	40½	41	42	42½	43½	44	45	45½	46½	47	48	48½	49	49½		
9½	28	29	30	31	32	33½	34½	35½	36½	37½	38½	39	40	41	42	42½	43½	44	45	46	46½	47	48	48½	49	50			
9¼	28½	29½	30½	32	33	34	35	36	37	38	39	40	41	41½	42½	43½	44	45	46	46½	47½	48	48½	49½	50				
9	29	30½	31½	32½	33½	34½	36	37	38	39	40	41	41½	42½	43½	44	45	46	46½	47½	48	48½	49½	50					
8¾	29½	31	32	33½	34½	35½	36½	37½	38½	39½	40½	41½	42½	43½	44	45	46	46½	47½	48	49	49½	50						
8½	30½	31½	33	34	35	36½	37½	38½	39½	40½	41½	42½	43½	44	45	46	46½	47½	48	49	49½								
8¼	31	32½	33½	35	36	37	38½	39½	40½	41½	42½	43	44	45	46	46½	47½	48½	49	49½									
8	32	33½	34½	35½	37	38	39	40	41	42	43	44	45	46	46½	47½	48½	49	50										
7¾	33	34	35½	36½	38	39	40	41	42	43	44	45	46	47	47½	48½	49	50											
7½	33½	35	36½	37½	38½	40	41	42	43	44	45	46	47	47½	48½	49½	50												
7¼	34½	36	37	38½	39½	41	42	43	44	45	46	47	48	48½	49½														
7	35½	37	38	39	40½	42	43	44	45	46	47	48	49	49½															
6¾	36½	38	39	40½	41½	43	44	45	46	47	48	49	50																
6½	37½	39	40	41½	42½	44	45	46	47	48	49	50																	
6¼	38½	40	41½	42½	44	45	46	47	48	49	50																		
6	40	41	42½	44	45	46	47½	48½	49½																				
5¾	41	42½	44	45	46	47½	48½	49½																					
5½	42	43½	45	46	47½	48½	50																						
5¼	44	45	46½	47½	49	50																							
5	45	46	48	49	50																								

STAIR ANGLES

TREAD + 2 RISER = 24 TO 25

Table of stair angles resulting from given tread and riser dimensions. Ideal conditions are included between zigzag lines

where there may be sleet, the railings may be somewhat higher.

On a narrow landing opposite the foot of a steep stair, the handrail should be provided with an additional member about 18 or 20 in. above the 42 in. rail to prevent a person from going over the railing should he fall on the stairs. Of course, only the upper handrail is required on the side of a stair adjacent to a wall, but there should be at least 2 in. finger clearance between member and wall.

Outdoor stairs, like platforms, in gas works and chemical plants where corrosion is severe, frequently have handrails of the solid bar and rod type as shown in Fig. 2. In order to simplify fabrication the stanchions are placed at 90 deg to the stair stringers rather than vertically. At the bottom of the stairs the round railing rods are extended beyond the stanchion and by means of two 90 deg bends, joined together.

All stairs having a width between stringers of 44 in. or more should be provided with handrails on both sides, although the lower member may be omitted along an adjacent wall. On narrower stairs the handrail on the right side when ascending may be omitted if desired, provided there is an adjacent wall or other protection.

The hazard of falling on a stair is always greater, and the result more serious, when a person is descending. Inasmuch as most persons keep to the right when passing one another, even on stairs, it is essential that a handrail always be provided for those going down the stairs.

Stairs 88 in. or wider should be provided with an additional handrail located midway between the other two handrails. Such a center railing need not have the lower member, but it is desirable that end stanchions extend high enough to be visible in a crowd.

Head Hazards

Head hazards are even more serious on stairs than on level floors and platforms. There is not only the danger of concussion but also the possibility of a person falling down a long flight of stairs after being stunned by the blow.

Referring to Fig. 3, which shows the general dimensions and clearances of an average man, it is in order to keep all overhead obstructions at least 7 ft vertically above the line of the nosings of the treads. Where a low beam or pipe unavoidably exists above a stair, the obstruction should be heavily padded and covered with lightweight canvas which should then be painted with 2 in. diagonal black and white stripes. In addition, a tell-tale of sash cords or sash chains knotted at their lower ends and spaced about 3 in. apart should be hung over the stairs about three or four steps below the obstruction. The lower end of the cords or chains should be about 3 in. below a line parallel with the stair stringer and just touching the under side of the obstruction.

Except at high-tension electrical galleries and other dangerous locations where men have to make a hurried exit, it makes little difference whether a door swings in or out. At stair landings there is always a hazard when a door swings toward the stair, especially if it is close to the top riser. For this reason, where practicable doors should be arranged to swing away from the head of a stair, unless the door when opened does not reduce the landing area. In any event, it is desirable to have glass lights of generous size in all doors near stairs.

How to Detect and Cure Wire Rope Troubles—II

A J Morgan, chief engineer, Wire-Rope Division, John A Roebling's Sons Co,
explains why and how rope life is shortened by defective and improperly operated sheaves and guide rollers, internal corrosion, shock loads and lack of lubrication

▶ THE ENGINEER, in looking for reasons why rope is short-lived, knows that all of them are not due to the drum or the way the rope winds onto it as explained in the previous article, February POWER. He will, therefore, examine the condition of the sheaves.

If he finds that the sheaves are of the proper diameter for the size of rope running on them, he inspects the radius of the rope-carrying grooves. These grooves must be cut to offer maximum support for the rope, without restricting normal rotation. Thus, if a sheave-groove radius is too large, Fig. 1, the rope is not properly supported in the groove and, under tension, has a tendency to flatten out. On the other hand, if a sheave-groove radius is too small, Figs. 3 and 4, the rope is pinched and an undue amount of rope abrasion against the sheave flanges takes place.

Groove Tolerance

The groove should support the rope for nearly one-half of its circumference, Fig. 2; thus, the groove radius must be slightly greater than that of the rope. The table on page 75 gives the proper tolerance by which sheave-groove diameter should exceed normal rope diameter for proper operation. Wire-rope manufacturers supply gages with which these grooves may be checked.

Results of improper sheave grooving will be, in addition to the distortion mentioned, excessive abrasive wear showing on the sections of rope that pass most frequently over the offending sheave. Thus, if you find that one section of a rope is more worn than others, you can locate the source of trouble, if it is a sheave, by noticing which one this section passes over most frequently in the course of normal service.

Eccentric rotation of a sheave can

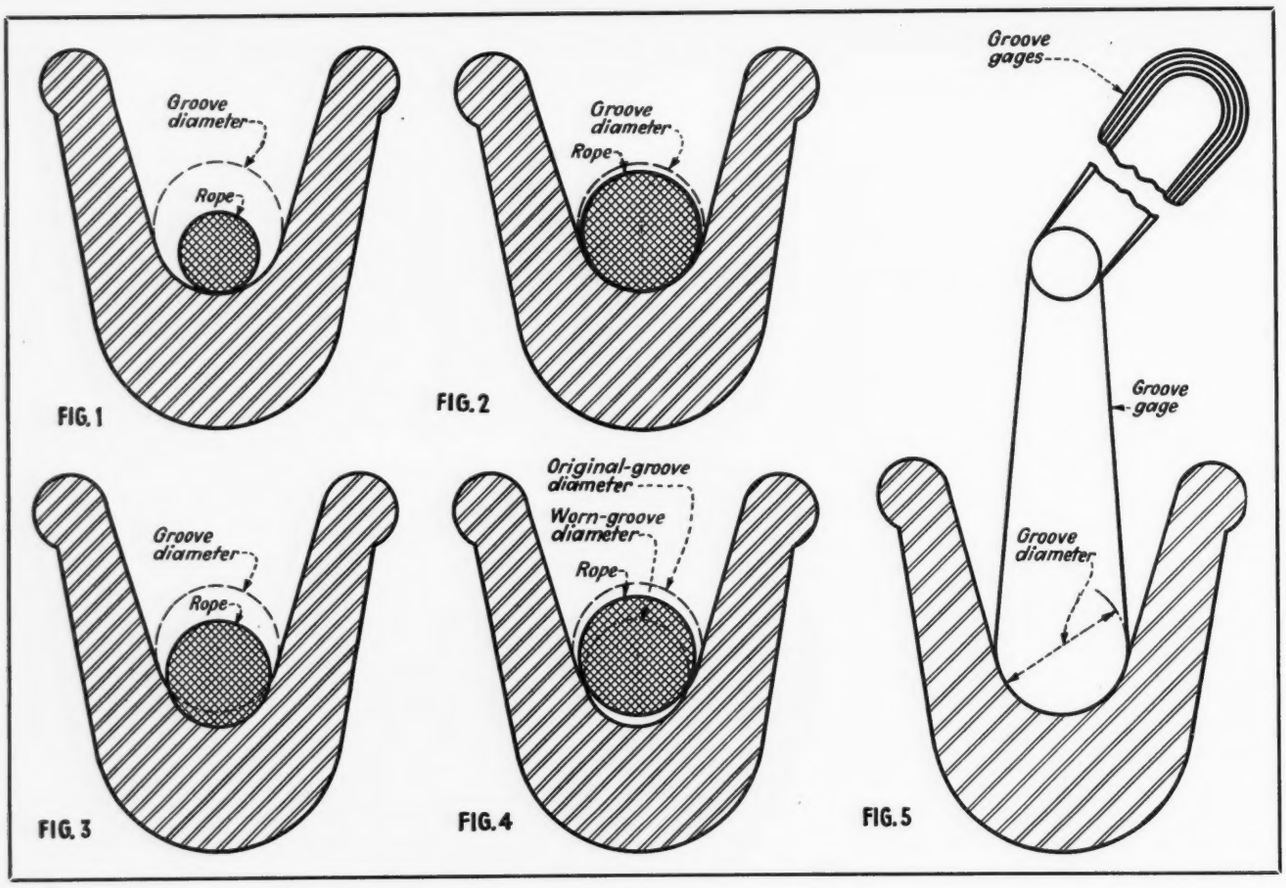


Fig. 1—If the sheave groove is too large the rope is not properly supported and it tends to flatten under tension. Fig. 2—The groove should support the rope for nearly one-half of its circumference. Fig. 3—A correctly designed sheave groove worn to decreased diameter of the rope. Fig. 4—New rope of normal diameter in a sheave groove worn by previous rope of decreased diameter. Fig. 5—Method of checking sheave grooves with a groove gage

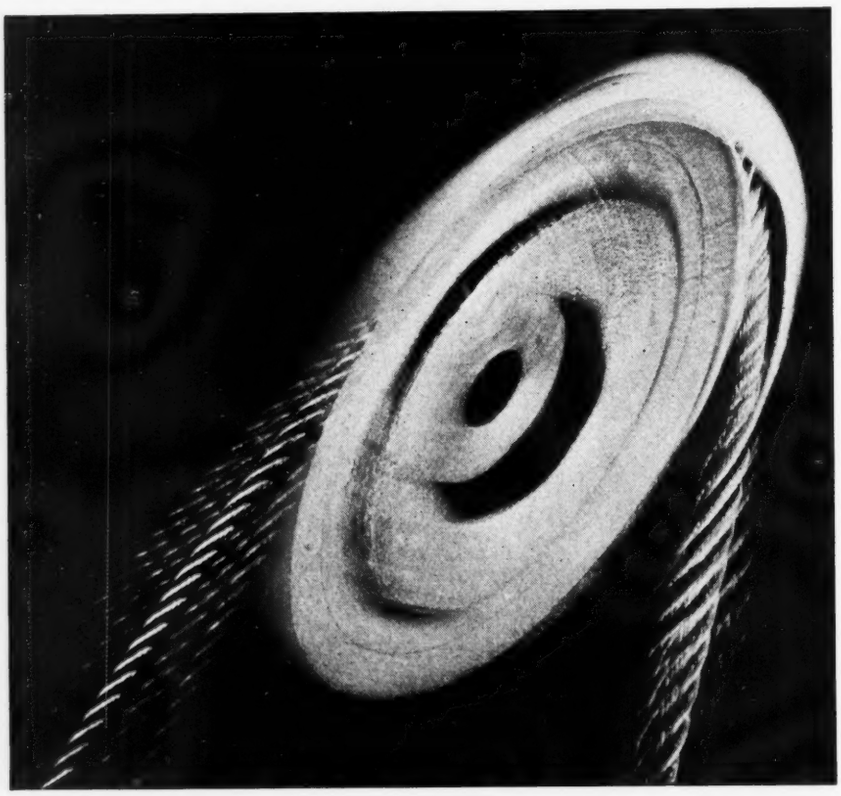


Fig. 6—An artist's conception of how a rope may whip and vibrate when running over an eccentric sheave represents closely actual experience

also be a source of rope trouble. This can be caused either by the sheave itself being out of round in its circumference, or by its being worn eccentric, which will set up a whipping action in the rope, Fig. 6. This action will have a severe fatiguing influence on the rope, concentrated in certain spots along its length. These spots, of course, vary in location according to the individual installation, but can easily be recognized by the fact that typical fatigue breaks in the wires will appear and increase rapidly in these sections.

Whipping Action

It is also possible for such whipping action to cause the rope to slap against some immobile part of the machinery. In such a case there will be evidence in the form of easily recognizable scrubbing and gouging of the wires.

It should be noted, however, that in some instances, a certain amount of vibration is inherent either in the machine itself or in the operation of the machine. Such vibration may cause whipping of the rope, and in such cases whipping is likely to be difficult to eliminate. This is especially true of some excavating machines, and also of some

drag scrapers where there is a heavy horizontal pull. Consequently, under these conditions, the maximum protection to the rope should be insured, if possible, by installing "whipping blocks," wooden blocks placed over any hard surface against which the rope might slap.

In installations where there are guide rollers, Fig. 7, to lead the rope into a sheave, another potential source of trouble exists. If these rollers become deeply grooved by the constant passage of the rope over them, Fig. 8, the edges of these grooves will cut the rope as it moves back and forth transversely across them. The surface of such guide rolls must be inspected and kept reasonably smooth. Care must also be taken that these rolls are free to rotate, for if they become "frozen," abrasion will increase.

Internal Corrosion

One of the most difficult sources of rope deterioration to trace down is internal corrosion. A rope in service cannot be opened up for internal inspection throughout its length and there are only two methods of establishing whether or not a rope is corroding inside. The first is inspection at the time cut-backs are made at the drum, or preferably at the bucket end. In this way you can get a fair idea of the condition throughout the rope length.

Where cut-backs are not made frequently, close inspection of the "valleys" between strands must be relied upon. If the rope appears dry and there is evidence of any pitting or rust in these valleys, internal corrosion is to be suspected. If there are wire breaks occurring in the valleys rather than on the crowns of the strands, an inspection of the broken ends will reveal whether corrosion, fatigue, overstressing or cutting is responsible.

Cutting will be the result of either of two conditions. Either there is a sheave with an under-sized groove, which is pinching the rope so tightly that the wires are cutting into each other, or the center of the rope has become so dried out that it no longer is offering sufficient support to the strands, which are cutting into each other.

Groove-Diameter Tolerance

Normal Rope Diameter, In.	*Proper Groove Clearance, In.*
1/4 to 5/16	1/64
3/8 to 3/4	3/32
13/16 to 1 1/8	5/64
1 3/16 to 1 1/2	1/16
1 5/16 to 2 1/4	3/32
2 5/16 and larger	1/8

Again, a condition of overstressing might have stretched the rope unduly, thereby reducing the diameter to such a degree that the strands have crowded together and allowed the individual wires to cut each other. A hemp center will collapse when it is not lubricated enough.

Where ropes are dragged through sand or any similar granular substance, it is not advisable to coat them with heavy lubricant. This causes the rope to pick up particles which will be ground into the small spaces between the wires and strands and will cause internal abrasive wear which can seriously weaken the rope. On such installations, ropes should be lubricated frequently with a light, penetrating preparation. The outside will probably not be seriously affected by corrosion because of the fact that passage of the rope through the sand will keep the steel bright and rusting will not gain any headway.

There are any number of unique potential causes of poor rope service which must be ascertained at the individual installation. For instance, if the rope comes into constant contact with any part of the machinery, undue wear will result. Or again, sudden shocks to a rope under tension will cause stresses which may produce tension breaks. In short, all manner of mechanical abuse must be taken into consideration when the causes of poor rope service are being investigated.

Short Rope Life

Having thus examined the rope and installation for all possible sources of trouble, the engineer is really just beginning his job. It is at this point that he must call upon his training and experience. Frequently, a number of conditions will be found on a machine that are not ideal for longest rope life. Yet some of these may have been present during the life of several ropes without having seriously affected their service. Then another factor, possibly equally as minor as those already existing, may enter the picture and tend to aggravate the situation, thus resulting in serious decrease in rope life.

For instance, a sheave may have been a trifle eccentric for some time without being noticed. Then, for some reason, one rope is not lubricated properly and corrosion gets a start. The rope will then be much more susceptible to the fatiguing effect of the whipping set up by the eccentric sheave. Broken wires appear much more rapidly than seems reasonable and the rope gets the blame. The engineer must be able to recognize the way in which the two factors work hand in hand, the one aggravating the other. He must be able to determine whether or not the expense of a new sheave would be warranted if the rope were properly lubricated.

Fig. 7 (top)—Guide rollers may also cause trouble if their grooves become worn or they do not run properly. Fig. 8—A rope running in a sheave groove worn like this is going to have short life no matter how good it is

It is impossible to make absolute general statements to cover all possibilities of rope service. Installations and their individual conditions vary as widely almost as do the personalities of the people who own them. The engineer's search for trouble on a rope installation may be summarized: to establish all possible causes of rope deterioration found on the installation or in other sources; to weigh the evidence thus collected in the light of its own value and of his experience; and finally, to determine whether or not the factors considered are sufficient to cause the rope deterioration. If, as we have assumed in these articles, the rope used was the proper one, in the vast majority of cases the cause of under-average rope service will be found in these factors or a combination of them.

Practical Methods of Diesel Heat Recovery

Glenn C Boyer, Burns & McDonnell Engineering Co, shows by typical installations and performances how to apply the first principles covered in October POWER

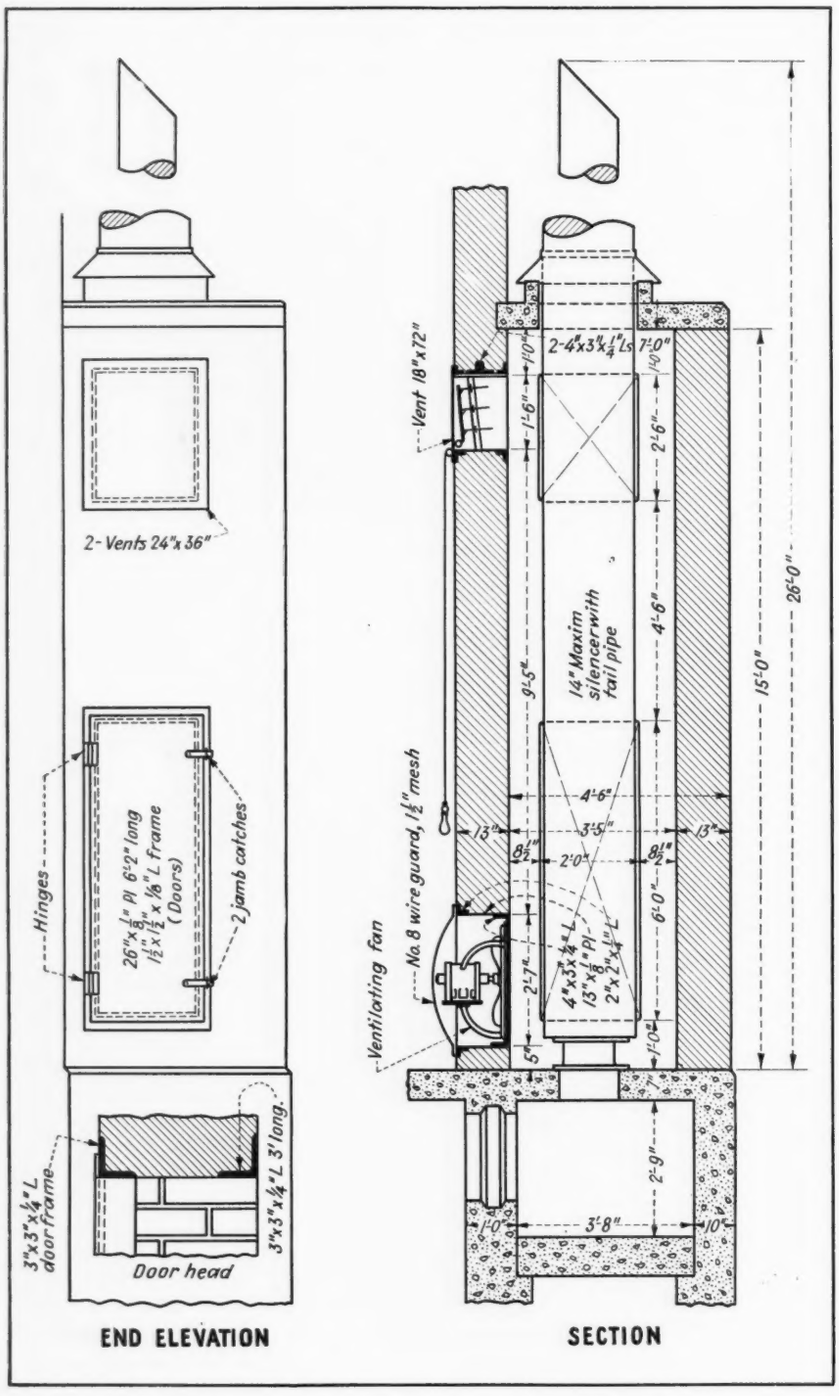


Fig. 1—Simple waste-heat recovery system for building heating

► THE VARIOUS METHODS of diesel heat recovery fall roughly into two classes: (1) those which do not employ a waste-heat boiler and (2) those that do.

An example of the first is building heating by enclosing the engine exhaust silencers and forcing air through the enclosure by means of a fan. One way of doing this is shown in Fig. 1. While no exact formulas are available for calculating the possible heat recovery from such a system, tests at Bloomington, Ill. (POWER, July, 1933, page 359) show that with engine-exhaust temperature of 320 F, inlet heating-air temperature of 71 F, and outlet temperature of 115 F, a heat recovery of 138,000 Btu per hr was realized when circulating 3000 cfm of heating air around the silencer. During this test, the engine was operating at approximately half load, 320 hp.

Plant Heating

From these data it appears that heating systems of this type will serve satisfactorily and furnish sufficient heat for a power-plant building when 5 cu ft of air per min per rated engine hp are circulated around the silencer. This rule-of-thumb guide may not always prove out in all cases. The problem of designing a satisfactory heating system as shown in Fig. 1 resolves itself into a question of passing enough air over the outside of the silencer in a given time to absorb up to a maximum of 30% of the heat in the exhaust gas.

Putting this into the form of an equation, we obtain

$$0.30\,H = 0.01659\,V\,(120 - t)$$

where H = Total heat in Btu passing through the exhaust silencer per min,

V = Cu ft of heating air circulated around silencer per min,

T = Inlet temperature of heating air.

This equation is based upon the assumption that the temperature of the

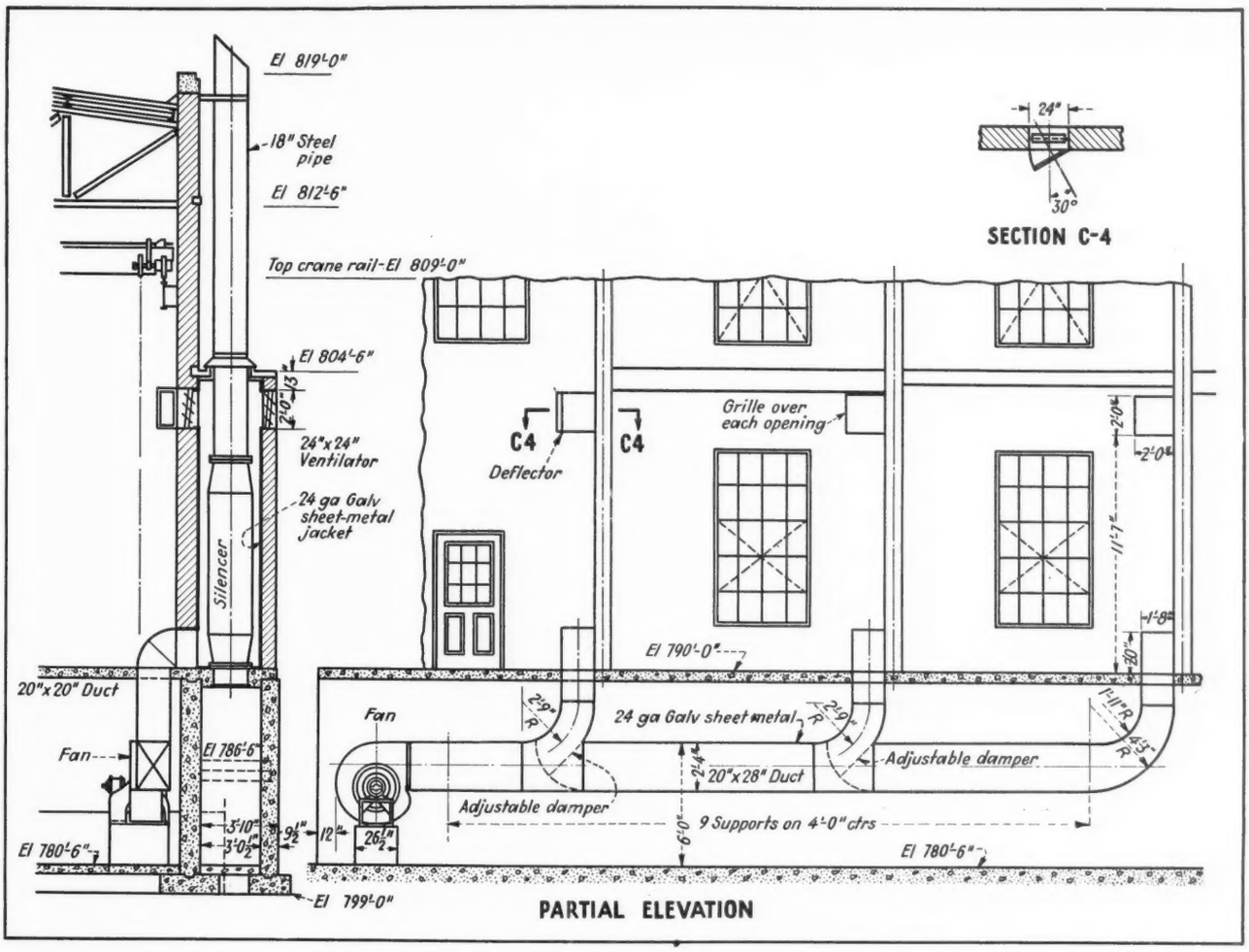


Fig. 2—Waste-heat reclaiming system for several engines

hot air entering the room is 120 F, with the heat carried per cu ft of dry air at this temperature being 0.01659 Btu per degree F.

In installations consisting of several engines, the author has used successfully an arrangement for building heating shown in Fig. 2. This scheme employs a single motor-driven blower and connecting duct work from the blower to all silencers. Dampers in the duct work allow the air circulation to be directed to the active silencers, or to be divided between the silencers in a way to secure the most effective heat distribution in the building.

A system of this type is now operating in a power plant with three 650-hp diesels. The fan provides 4500 cfm of air at a static pressure of 1 in. of water. The entire cost of fan, duct work, brick enclosures around the silencers, and adjustable louvres was approximately $750, a low cost for the heating system in a building about 40 x 70 ft.

Commercially designed air heaters have been used for recirculating heat from exhaust gas. Data available on these units indicate that they can recover as much as 35% of the available heat in the engine exhaust at full load.

Hot water can be obtained from exhaust heat by installing a pipe coil in the engine muffler, or a water jacket around the exhaust line. A pipe coil consisting of 2 ft of 1¼-in. pipe per rated engine hp when operating with 2-cycle engines will recover approximately 400 Btu per hp output at full load, or about 27% of the heat in the exhaust. This is on the basis of clean tubes. When such coils are installed in exhaust lines or mufflers, provisions should be made to facilitate removal for cleaning.

A hot-water jacket constructed around the engine exhaust line will absorb roughly 3000 Btu per sq ft of pipe in contact with the water. This figure is based upon an engine operating at full load, exhaust temperatures ranging between 400 and 450 F and a heating area of 0.1 sq ft per rated engine hp. At fractional loads on the engine the heat transfer to water from the exhaust gas will be less due to the lower exhaust temperatures. This applies both to the pipe coil and the water jacket.

So far the only source of waste heat considered has been the diesel exhaust. Another heat-reclaiming system utilizing heat from the cooling water has

TABLE I—WASTE-HEAT-BOILER TEST RESULTS

(4-cycle, 17½ x 25-in., 225-rpm, solid-injection engine at Cushing, Okla.)

Engine load	½	¾	4/4
Horsepower output	375	562.5	750
Lb fuel per hphr (19,270 Btu per lb)	0.400	0.353	0.349
Btu input to engine per hphr	7700	6800	6720
Exhaust temperature off engine, F	395	470	640
Lb steam produced per hour	23	220	226
Lb steam produced per hphr	0.061	0.392	0.302
Steam pressure, lb per sq in. g	2.0	4.0	7.8
Feedwater temperature at boiler inlet, F	98	93	92
Btu added per lb steam	1089	1096	1099
Btu recovered per hphr	115	430	332

TABLE II—WASTE-HEAT BOILER PERFORMANCE DATA

FOUR-CYCLE DIESEL ENGINES

Hp	Lb Steam per Hr Full Load			Lb Steam per Hr ¾ Load			Lb Steam per Hr ½ Load			Sq Ft Ht Surf
	5 lb psi	10 lb psi	15 lb psi	5 lb psi	10 lb psi	15 lb psi	5 lb psi	10 lb psi	15 lb psi	
75	77	74	72	60	58	56	44	42	40	72
100	92	89	87	72.5	70	67	53	50.4	48.5	72
200	154	150	147	122	118	115	90	85	81.5	72
300	212	205	199	167	160	156	122	116	111	72
400	327	316	309	257	248	240	188	178	171	144
500	392	380	372	310	298	290	226	215	205	144
600	483	466	455	380	366	354	277	265	253	192
700	550	530	520	432	417	404	317	301	287	192
800	638	617	600	504	481	468	368	348	334	240
900	700	675	664	550	530	515	414	383	366	240
1000	780	750	735	612	588	572	450	425	416	288
TWO-CYCLE DIESEL ENGINES										
75	63	60	57	40	37	34	17	14	12	72
100	78	74	71	49	45	42	21	17	14	72
200	165	157	150	102	94	88	44	36	30	144
300	229	217	208	144	133	124	60	50	42	144
400	300	285	273	191	176	165	80	66	55	192
500	370	351	336	234	216	202	98	80	68	240
600	450	427	410	282	260	244	118	98	82	288
700	525	498	477	330	305	285	139	115	96	336
800	600	570	545	378	358	320	158	130	109	384
900	675	640	615	425	393	368	178	147	123	432
1000	750	710	682	475	440	410	198	163	136	480

BASIC DATA:

Gas Flow

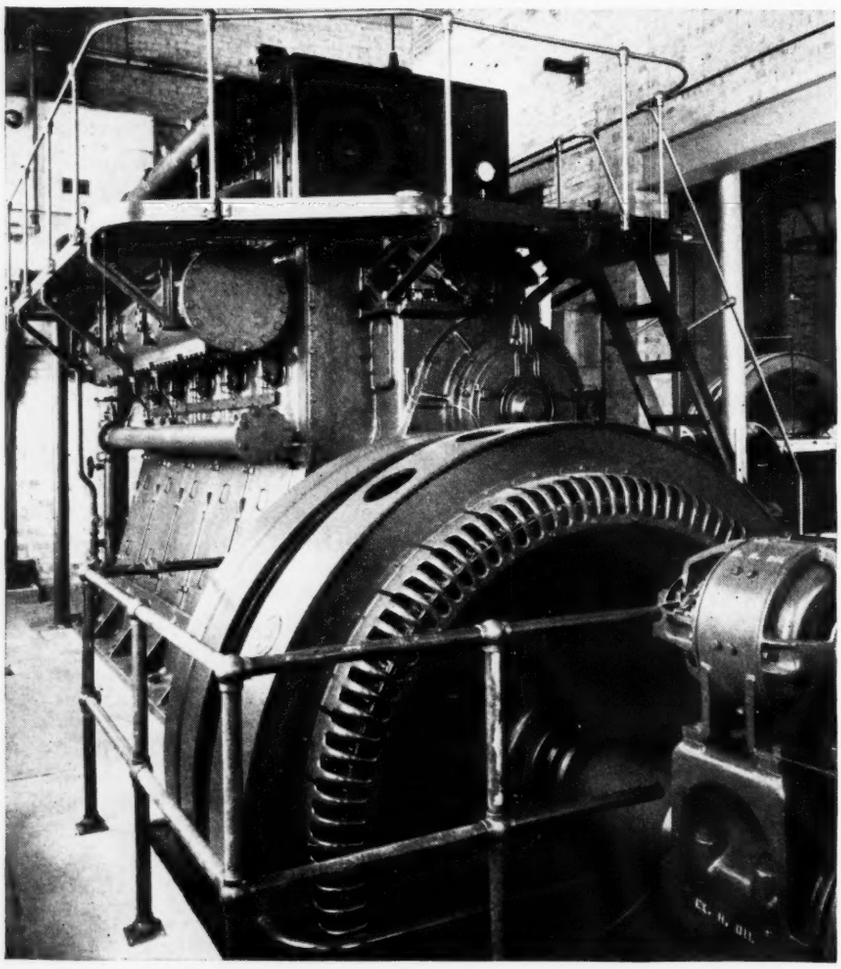
4 cycle = 12 lb per rated hp
2 cycle = 20 lb per rated hp

Gas Temperatures

	4 cycle	2 cycle
Full load =	700 F	500 F
¾ load =	600 F	400 F
½ load =	500 F	300 F

Feedwater

140 F



Waste-heat boiler supplies process hot water in a coating mill

recently come to my attention. In a diesel-powered manufacturing plant, heating facilities for the building and the cooling-water system for the diesels are combined.

The cooling water is circulated through six unit heaters, in various parts of the plant. Each unit heater has a fan for forced-air circulation, and two sets of adjustable louvres thermostatically operated. One set of louvres is on the face opposite the fan and when open, the circulated air is forced out into the room. The other set is in the top of the unit heater and when open, circulating air is forced out through a ventilator in the roof.

Louvre Arrangement

When the temperature inside the building falls below 70 F, a thermostat closes the louvres in the top of the unit heater and opens the set admitting warm air into the building. As soon as room temperature reaches 70 F, the thermostat closes the louvres admitting air into the room, and opens the set on top, thereby forcing warm air out of the building.

This arrangement has the following features: (1) Eliminates a cooling tower for conditioning jacket water, (2) provides a closed cooling system for the diesel engines, (3) provides heat for the plant throughout the heating season and (4) ventilates the plant during the rest of the year.

Since the diesels operate only during the day, two small oil-fired heating boilers are installed to maintain room temperatures at night during the heating season. A heating coil, in the exhaust pit, common to the engines in the plant, provides enough hot water for wash-room purposes. This is the only use made of the heat in the exhaust. (See POWER, June, 1940, page 68, for another application of this general scheme at Littlestown Hardware & Foundry Co).

The heat-reclaiming methods so far considered have not required any changes in the normal arrangement of engine auxiliaries. There remains for consideration one heat-reclaiming device, the waste-heat boiler, which, in a measure, takes the character of an added auxiliary.

To work satisfactorily with a diesel engine, the waste-heat boiler, utilizing the exhaust gas as a source of heat, should have the following characteristics: (1) A good heat-transfer rate at the temperatures found in diesel-engine exhausts, (2) resistance to corrosion from moisture and dilute acids, (3) accessibility for cleaning carbon deposits and scale formations, (4) good exhaust muffling, (5) gas-tight construction, (6) provision for independent oil firing, (7) minimum increase of exhaust backpressure, (8) minimum amount of attention and maintenance, (9) minimum of boiler accessories, and (10) low first cost.

While these requirements specifically set forth resistance to corrosion, the Diesel Engine Manufacturers' Association in their "Standard Practices" strongly recommend that exhaust gas temperatures be kept above the dew point in order to minimize corrosion difficulties.

Waste-Heat Boilers

Waste-heat boilers on the market at present can be classified in the same general manner as conventional steam-generating units, that is, (1) fire-tube and (2) water-tube. Although the Clarkson or "thimble-tube" boiler falls into neither of these classifications, it has been fully described elsewhere[1], to which I would like to add the data shown in Table I. This covers the use of a No. 8 Clarkson boiler with a 750-hp, 4-cycle, solid-injection engine.

The test data in Table I is not complete in that temperatures of the exhaust gas entering and leaving the boiler are not given. Peculiarly, these data show a greater heat recovery at ¾ load than at full, although the exhaust gas is 170 F hotter at full load.

In order to approximate the quantity of heat recoverable from the exhaust of a diesel engine, Bradford and Clarkson[1] developed the formula:

$$H = \text{B hp} \times C \times \frac{D}{4}$$

where H = Total heat recovered in Btu,
B hp = Engine brake horsepower,
C = 12 for 4-cycle engines, 20 for 2-cycle engines,
D = Temperature drop of gases

When this formula is applied to the test data in Table I, gas temperature drops through the boiler appear to be somewhat erratic. This is probably due to the fact that the Btu recovery at ¾ load was greater than at full load.

To approximate the probable heat recovery, I have prepared Fig. 3 from data at my disposal. This chart (not based upon the Bradford-Clarkson formula), developed for solid-injection engines, permits a rapid check of the characteristics of exhaust gas for heating purposes. Starting with the rated engine hp, the following items can be obtained in succession:

(1) Quantity of exhaust gas per hour (which remains constant for all loads), (2) total heat in the exhaust above 60 F (knowing the exhaust gas temperature), (3) total heat economically recoverable in Btu, and (4) total quantity of hot water or steam produced with inlet water temperature of 60 F.

Practical Example

The example shown on Fig. 3 (see dotted lines and arrows) is for a 750-hp, 4-cycle engine, considered to have an exhaust-gas temperature at full load of 700 F. The chart shows that approximately 8000 lb of exhaust gas are available per hour carrying about 1,400,000 Btu of heat above 60 F.

The series of solid lines in the lower right-hand portion of the chart are to be used for determining the quantity of heat economically recoverable in hot water, while the dashed lines are to be used for determining the quantity of heat economically recoverable in the form of steam at 5 lb g pressure. The temperature values carried by these lines correspond to the exhaust temperature under consideration; in this example 700 F.

Thus, with a total of 1,400,000 Btu

(Continued on page 166)

[1] "Heat Recovery from Internal-Combustion Engines," by Thomas Clarkson and William Bradford, *Transactions ASME*, Sept-Dec 1931, Oil & Gas Power Div—53-4, page 59.

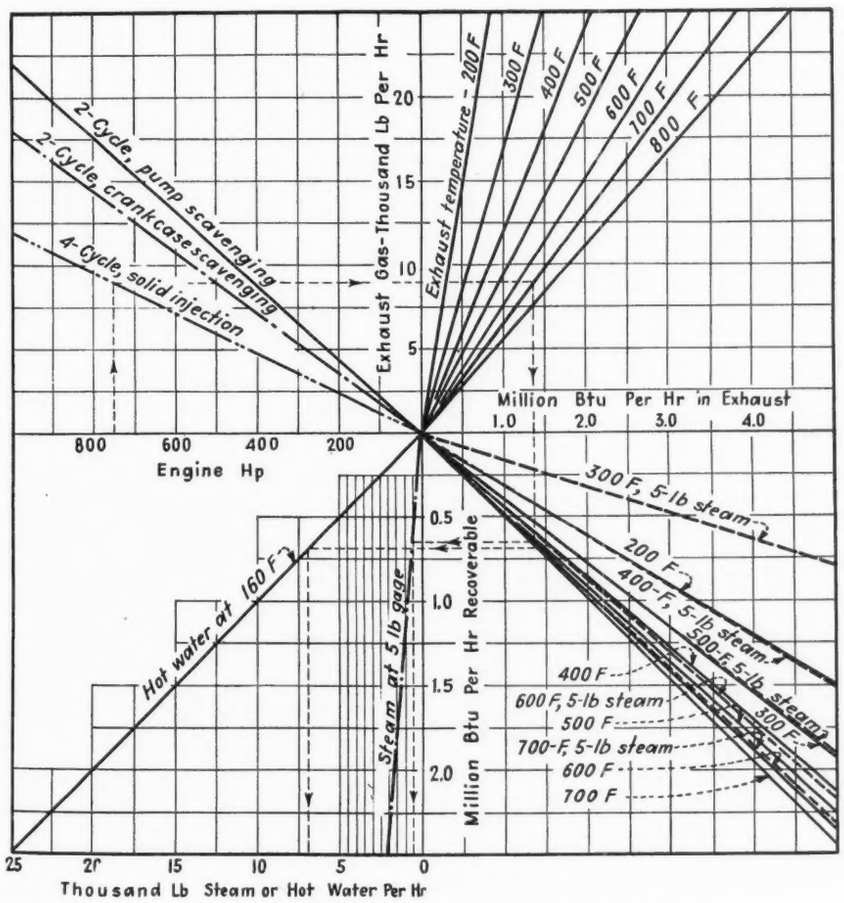


Fig. 3—Determining economical heat recovery from engine exhaust.

"Boiler Booster" Gives Quick Capacity Increase

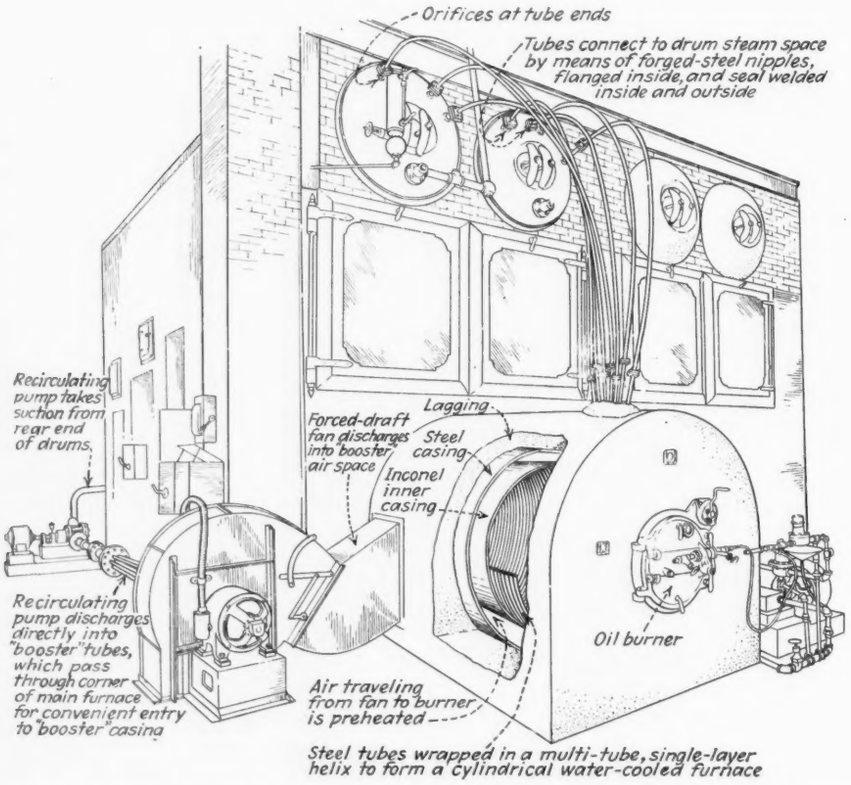
Water-cooled high-heat-release oil-fired unit added to existing boiler at Altman's produces more than 50% output increase; standardized "boosters" may prove an answer to today's emergency capacity needs

►A 5-FT DIAMETER, 8-ft long oil-fired booster set in front of a veteran 2380-sq-ft boiler in the B Altman & Co plant (famous New York department store) looks like the answer to at least one of the power engineer's current emergency problems. Utilizing controlled forced recirculation to permit high rates of heat absorption and thus to cram maximum firing capacity into minimum space, this unit has increased the 35-year-old boiler's steaming capacity by more than 50% and jacked up efficiency to boot.

The basic idea of the "boiler booster" is simple. As set up at Altman's, a circulating pump takes a constant quantity of water from the drums and forces it through a group of tubes forming a cylindrical water-cooled auxiliary furnace; the steam-water mixture from these tubes feeds back into the steam space of the existing boiler drums. Partially cooled gas from the booster furnace, where all combustion takes place, passes into the main boiler furnace and over the heating surfaces in the usual fashion.

The photo shows the actual installation and W D LaMont, the inventor, while the perspective drawing gives a clearer picture of the details. This frankly experimental unit was largely fabricated and assembled in the Altman shops, through the cooperation of Joseph A Cummings, Chief Engineer. The photo also shows part of the calorimeter installation and other test instruments with which Consolidated Edison engineers plan to determine the actual rates of heat absorption in the furnace. Results of these tests will be available shortly.

In the perspective drawing, the circulating pump can be seen at the left. This pump takes suction by means of two 4-in. extra-heavy pipes connected to existing openings at the rear of the drums, below water level. The pump discharges through extra-heavy pipe straight into the inlets of seven 1¼-in., 0.042-in. wall, Inconel tubes. The tubes, 100 ft long, enter the main boiler furnace at the side near the front and pass into the booster shell where they are wrapped in a single-layer helix to form the cylindrical furnace. An Inconel sheet surrounds the tubes and forms, with the outer steel casing, space through which combustion air passes from the forced-draft fan to the burner set in the front of the booster casing.

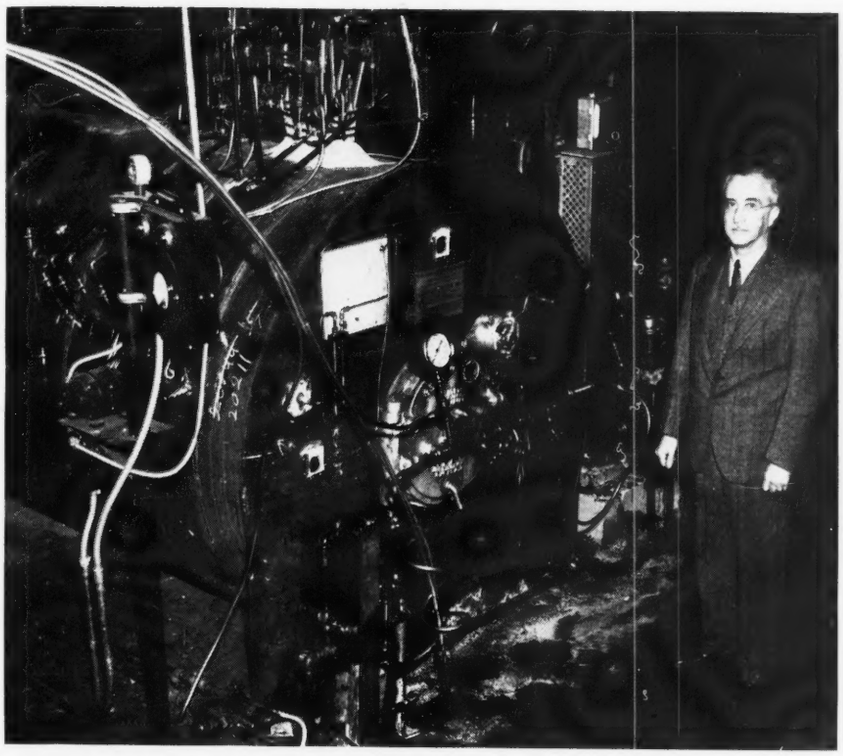

Orifices at tube ends
Tubes connect to drum steam space by means of forged-steel nipples, flanged inside, and seal welded inside and outside
Recirculating pump takes suction from rear end of drums
Lagging
Forced-draft fan discharges into booster air space
Steel casing
Inconel inner casing
Recirculating pump discharges directly into "booster" tubes, which pass through corner of main furnace for convenient entry to "booster" casing
Oil burner
Air traveling from fan to burner is preheated
Steel tubes wrapped in a multi-tube, single-layer helix to form a cylindrical water-cooled furnace

Details of "boiler booster" installation at B Altman & Co, New York. Test apparatus and non-essential equipment has been eliminated for clarity

Drum Connections

The booster tubes terminate in flanges outside the casing. Connecting tubes carry the steam-and-water mixture from this point to the drums; three tubes enter the left drum and four enter the right. Connection to the drums is made by means of forged-steel nipples with inside flanges; these are seal welded inside and outside. Orifices at the tube exit ends and direct drive into the inlet ends control distribution in the tubes, taking care of inequalities in heat absorption. Placing orifices at the tube exit instead of the inlet, as is usual practice in European LaMont boilers, makes it possible to use a large opening and thus avoid danger of plugging with impurities.

In common with other LaMont boilers, no special controls are required. The recirculating pump, entirely independent of the existing boiler-feed



W D LaMont, inventor, at the firing end of the Altman "booster"

pump, recirculates a constant quantity of water regardless of load. Changes in load, and thus in firing rate, are reflected in a change in the steam-water ratio in the booster outlet tubes. In this installation, and in any normal installation, feedwater input is regulated from the drum water level in the usual fashion. This installation has been operated with automatic control of fan and burner operation but manual control can be used where desired. A built-in control shuts off the burner if the recirculating pump stops for any reason.

Constant high rate of flow through the tubes makes possible extremely high rates of heat absorption and this, in turn, makes possible heavy firing in a small space. The unit at Altman's has been operated at a burning rate of 1800 lb of oil per hr, giving a heat release of 325,000 Btu per cu ft per hr. Tests at Philadelphia Navy Yard, of a complete LaMont boiler, with a furnace similar to that of the booster, show it is possible to go as high as 1,000,000 Btu per cu ft per hr.

Gas leaves the booster unit, in this case, at about 1800 F; this gives a main furnace temperature considerably lower than if it were direct fired and its operation thus closely approximates that of a waste-heat boiler. When operating the original boiler at its peak rating of 150%, stack temperature ran more than 600 F. With the booster in operation, and at a total output corresponding to more than 250% of rating, the stack temperature averaged about 450 F. This indicates a definite gain in efficiency. With the booster installed, a greater weight of gas passes the old heating surfaces in a given time, but temperature entering the tube banks is considerably lower. The net effect of these opposing changes, in this case, at least, is a lower stack temperature.

The installation at Altman's is experimental; the inventor's organization, W D LaMont Steam Generators, Inc, proposes to simplify and standardize the design, making a "packaged" unit for quick installation. Units will probably be made in two, or at the most, three sizes. The largest of these will have a 5-ft square burner front and will be 8 ft long. A flanged inlet connection, at the casing, will carry twelve 1½-in. tubes which form the water-cooled furnace, and two outlet flanges, carrying six tubes each, will be provided. Drum connections required will thus be reduced to a minimum of two.

The burner fitted to this unit will be capable of handling 3000 lb of oil per hr. For larger capacities, several of these units can be used. Mr LaMont believes that a "packaged" booster unit could be installed, in the average case, over a weekend, providing all necessary preparations were made before the boiler was removed from service. Speed of fabrication, delivery and erection represent a major advantage of this unit.

In many respects the installation at Altman's, where the booster replaces former firing equipment, is typical. There are, however, other interesting possibilities. Proposals under consideration include an installation in conjunction with existing pulverized-fuel equipment and another for stoker-fired boilers. In the first case, the booster would operate in combination with the coal burners, increasing the total heat input. It is believed that this arrangement would actually permit an increase in coal-firing rate, because the introduction of the relatively cool gas from the booster would lower furnace temperature and so avoid slagging difficulties now encountered at high-rating operation.

In Stoker Furnace

In the second case, the booster would be installed at the back of the furnace and operate as the sole firing equipment, although the stoker would not be removed. This change would increase the boiler output and give quick starting characteristics needed for proposed standby operation. There seems to be no reason why the booster could not be operated in conjunction with the stoker but the proposal does not envisage this combination.

Another interesting possibility is the use of boosters to increase superheat in plants where prime-movers are good for higher total temperature than the boilers will produce. In such a case, steam from the existing superheater outlet would flow to the booster, which would thus become a steam-cooled rather than a water-cooled furnace.

Practical Problems

In all these applications of a sound basic idea, certain practical problems must be considered. In the first place, suction and discharge connections to the drums must be made with an eye to boiler codes and insurance company regulations. Increased feedwater input may exceed capacity of existing pumps and piping, although Mr LaMont believes that most older installations were designed with sufficient conservatism to enable operation at the increased rate without major change. This is probably true of piping, where velocities can be increased over older practice without harm, but need for added pumping capacity must be carefully investigated.

A similar situation exists in the draft circuits. Firing greatly increased quantities of fuel means more weight of gas to be handled by breeching and stacks, and by induced-draft fans, where installed. To some extent this weight increase will be offset by lower gas

(Continued on page 168)

Voltage Control Extends Motor-Speed Adjustment

System of control for small and medium-size motors, used where solely alternating-current is available, removes the old barrier to wide ranges of speed adjustment

By PAUL W ARNOLD
Manager of Machinery Applications
Reliance Electric & Engineering Co

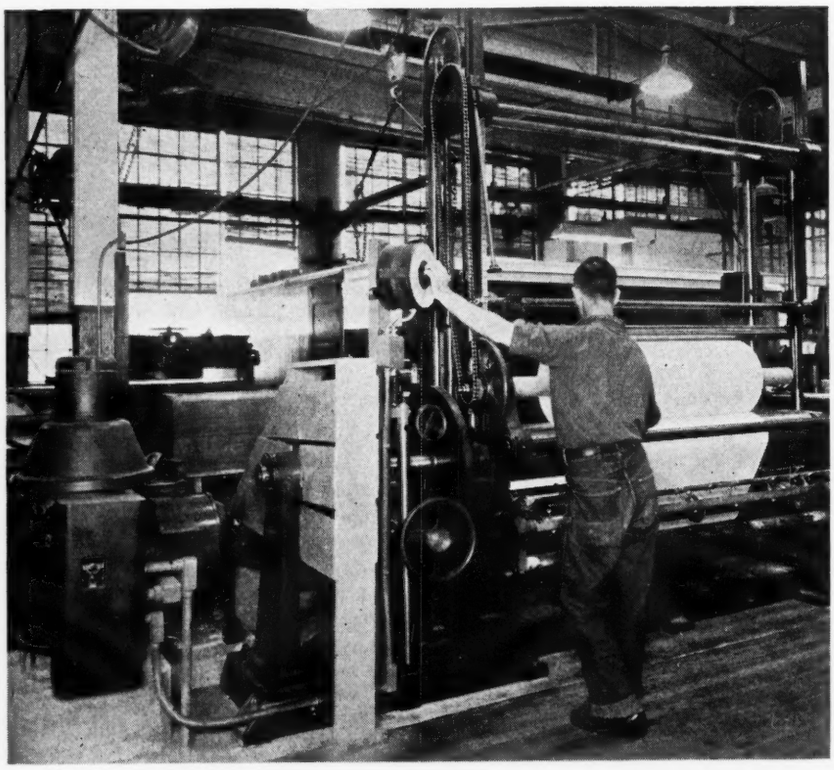


Fig. 1—A surface-type winder must operate over wide speed ranges. Low speed for threading and setting-up, smooth acceleration and stopping are required; all are obtained by the operator turning a simple field rheostat

▶ FOR EVERY MANUFACTURING STEP there is a right speed or best rate of operation at which a machine or group of machines must run to obtain the most satisfactory results. Two considerations complicate the problem of providing the correct speed: kind of power available and the varying duties of machinery in industrial plants.

When direct-current power was widely available, speed of machines could usually be controlled by regulating speed of the driving motor. With the widespread use of alternating current the problem became more complicated, because alternating-current motors do not readily lend themselves to wide ranges of speed control.

Machine-Speed Needs

Many industrial machines are general-purpose units frequently requiring a different speed for most efficient performance of each job. In many operations, highest efficiency can be attained only if several speeds are available for different stages of the same job. Other processes require a slow speed for making ready and a high speed for running.

Where the factory size or the horsepower rating justifies installation of a direct-current power supply, the problem of adjustable-speed is fairly easily solved with any one of several well-known methods of direct-current-motor speed control. When the power installation is small, say 50 hp and less and solely alternating-current is available, then the problem of speed adjustment becomes difficult. Induction motors are inherently constant-speed machines with their upper speed limit fixed at 3600 rpm and their lower limit around 450 rpm on 60 cycles.

Many designs of variable- and adjustable-speed alternating-current motors have been developed, all of them more or less complicated. Some have commutators; others use commutators and slip rings; still others depend upon a change in the frequency and voltage of the power system. None of these is entirely suited to general applications where wide speed adjustment is required.

In medium- and large-size units where large speed-control ranges are needed, the voltage-control (Ward-Leonard) system has been developed and used for many years to meet the most exacting speed-regulation requirements. Improvements in motor and generator design have now made it economically possible to extend the use of this system down to motors of 1 hp in size.

This drive, Fig. 3, consists of a control unit, a motor on the driven machine, a speed-adjusting rheostat, and start and stop pushbuttons. Fig. 2 is a diagram of the drive. The exciter and generator are mounted on the same vertical shaft with the alternating-current motor that drives them. These machines comprise the control unit. The exciter provides constant voltage to excite the generator and the motor field coils. The generator armature connects directly to the machine-driving-motor armature through a single-pole contactor and

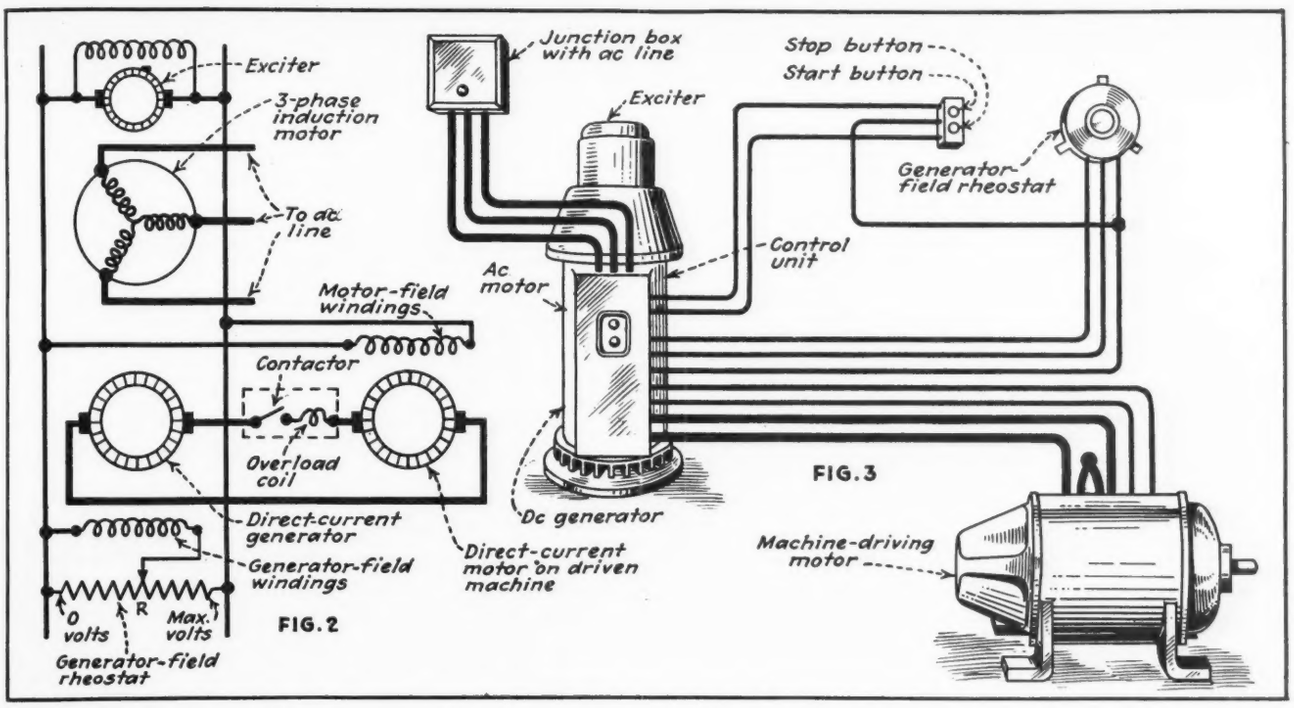


Fig. 2—Diagram of a variable-voltage control equipment. Fig. 3—Complete variable-voltage control equipment. The control unit consists of an exciter, dc generator and an ac driving motor all mounted on a common shaft. The motor is pushbutton started and stopped and speed of the machine-driving motor is controlled by a rheostat in the generator field circuit

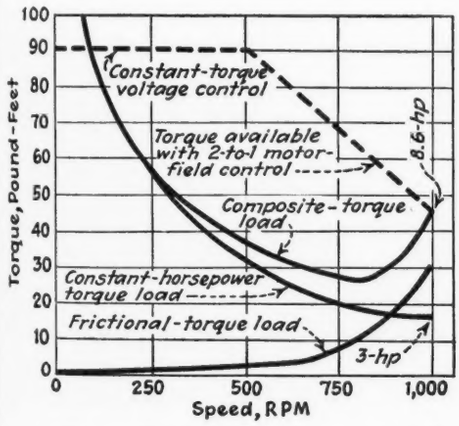


Fig. 4—Torque curves of motor under voltage-speed control

overload coil. Speed of the machine-driving motor is controlled by a rheostat *R* connected into the generator field-coil circuit.

When the generator field coils are connected to the right-hand end of the rheostat, they are directly across the exciter and generator voltage is at a maximum. When the generator field coils are connected to the left-hand end of the resistance, they become short-circuited and generator voltage is practically zero, being only that produced by the residual magnetism in the pole-pieces. Between these two points the voltage can be adjusted between residual and maximum, usually 250 volts.

This adjusted voltage is applied directly to the armature of the motor which varies its speed from essentially zero at residual volts to maximum at top voltage. Highest motor speed bears a fixed relation to maximum generator voltage and may be selected within a range of 200 to 5000 rpm, depending upon the size of the motor and driven-machine requirements.

Machine-Driving Motor

Even though the motor will run from zero to maximum speed, its practical full-load operating range is about 10 to 1, that is, down to 0.1 of maximum speed, for continuous-duty operation. From speeds of 10% of maximum downward, operation for varying periods at full load, or continuous operation at reduced loads, are possible.

By simply connecting a resistance in series with the field coils of the motor, other factors being held constant, its speed may be increased by as much as 6 times, giving a 60 to 1 operating range. In general, this method is used to increase the motor speed from 10 to as much as 300%.

The speed as set by the rheostat is relatively constant and does not change greatly with load. When maximum voltage is applied to the armature of the motor (maximum speed condition), the speed variation from zero to full load is about 10%. The same variation in speed is present at all voltages or speed settings. Few machines vary from zero to full load in their power requirements, so only a part of the speed change proportional to the load change actually takes place.

Over the voltage-control portion of the speed range (residual to maximum voltage), the motor develops constant torque. As resistance is added to the field coils of the motor its torque falls off directly with the speed, and constant horsepower is developed. Such a motor is usually geared or belted to the driven machine so that the smaller torque at high speed is equivalent to the higher torque at 230 volts and full field, without resistance in series with the motor field coils. The result is, therefore, more torque available as the motor slows down. This is desirable when there is heavy torque demand at low speed, or conversely, if good regulation (low speed change with load change) is required.

Demand Torque

The characteristics of voltage control for these small adjustable-speed applications are especially useful. We are accustomed to thinking of motor torque in terms of break-away or starting torque, since that is a limitation of a squirrel-cage motor, which develops its break-away or starting torque in 1/120 of a sec (½ cycle). The amount of torque available for acceleration then varies, depending on the design of motor selected. It must be remembered that this torque is developed whether the load requires it or not.

A voltage-control system, on the other

hand, develops what we might call a "demand torque" at all times, that is, a torque within the limits of the physical capacity of the equipment being driven. Two types of acceleration are possible. In one, the speed-adjusting rheostat is returned to zero-speed position. The driven machine can then be accelerated to the desired speed at any rate, limited only by the rate at which the speed-adjusting rheostat is rotated. Amount or torque developed is simply that required to accelerate the load smoothly at the desired rate.

If, on the other hand, acceleration to a predetermined speed is required, it, too, can be obtained from the inherent characteristics of the voltage-control system. The torque again provides smooth acceleration and does not subject the driven equipment to undue shock.

Operating Torque

Consider also the torque available over the whole operating speed range, which we may call "operating torque." If, for example, you have a drive which provides 10 hp at 1000 rpm, 52.5 lb-ft of torque are developed at that speed. A voltage-control drive develops essentially that same 52.5 lb-ft, or constant torque over its entire speed range. Some applications require constant horsepower, or at least a torque greater than constant over a wide speed range. It is in this connection that voltage control is least understood and most widely misapplied.

We should consider the following points when analyzing an application for a voltage-control drive:

1. Generally, when a machine is operated over a wide speed range, friction may constitute a large part of the load. Actual load readings should therefore be obtained. In general, the torque requirement will rise with an increase in speed.

2. Before it is decided that constant horsepower is required over the entire operating range, the actual torque should be checked and the machine examined to determine whether it was designed to stand the torque available. For example, the 10-hp, 1000-rpm constant-horsepower motor, if operated at 1/20 of its speed, would develop 1050 lb-ft of torque, 20 times full-load torque at 1000 rpm. Experience has shown that voltage-control systems will develop ample torque in practically every application.

Let us consider a hypothetical case, assuming the loads shown in the curve, Fig. 4. The frictional-load curve is taken from a variety of tests. The constant-horsepower-load torque curve is calculated from an assumed 3 hp at 1000 rpm. Of course, as we near zero speed we approach infinite torque. We have selected a motor that will produce constant horsepower from 500 to 1000 rpm, and constant torque from 500 rpm downward. These curves look strange because we usually plot them in terms of horsepower and not torque.

Obviously, if we actually provided constant horsepower we would have torque enough to break our machine at very low speeds. Conversely, we must actually determine how much torque the machine will stand at these low speeds and work backwards to match the required torque as nearly as possible with the available motor torque.

This engineering approach brings out many valuable points and leads to a more intelligent application of equipment to the job.

When, for example, we are considering an application of adjustable-speed drive to a machine tool, the most pertinent questions are: (1) What is the horsepower required at the low speed? and (2) how wide a speed range is desired?

Applications

It can be proved that the horsepower required to remove a given volume of metal is constant. In other words, a heavy cut at low speed removing 0.5 cu in. per min takes the same horsepower as a light cut removing an equal amount of metal per minute at 5 times the surface speed. Hence, constant-horsepower motors have always been applied to metal-removing machine tools. There are, however, other considerations.

Powdered-fuel feeders and stokers are applications where voltage-control drives are very useful. Only constant torque is required, so that the smallest and lowest cost motor may be used. But of greater importance than this is the

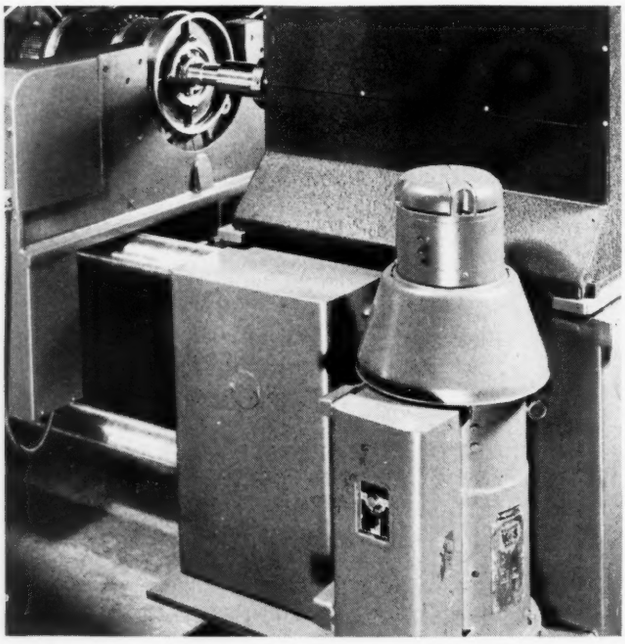


Fig. 5—Vertical voltage-control unit mounted directly on machine for balancing armatures gives wide range of speed control and smooth acceleration

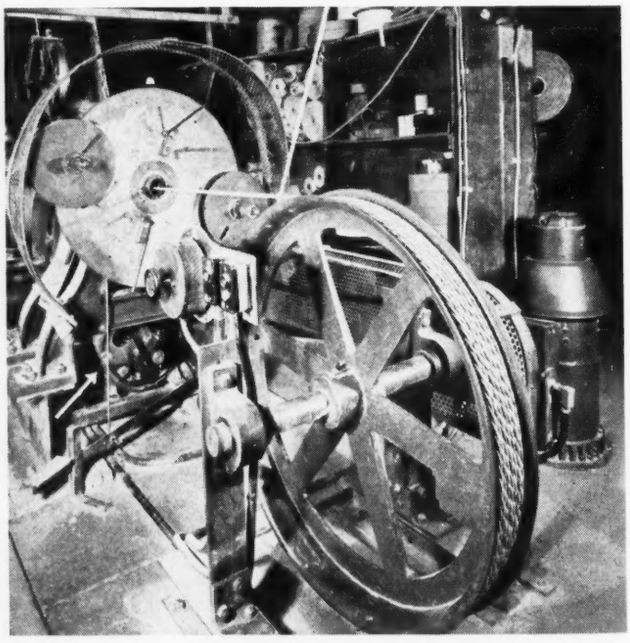


Fig. 6—Voltage control on cable-taping machine synchronizes speed of taping head with rate of cable delivery from the reel to lap the tape properly

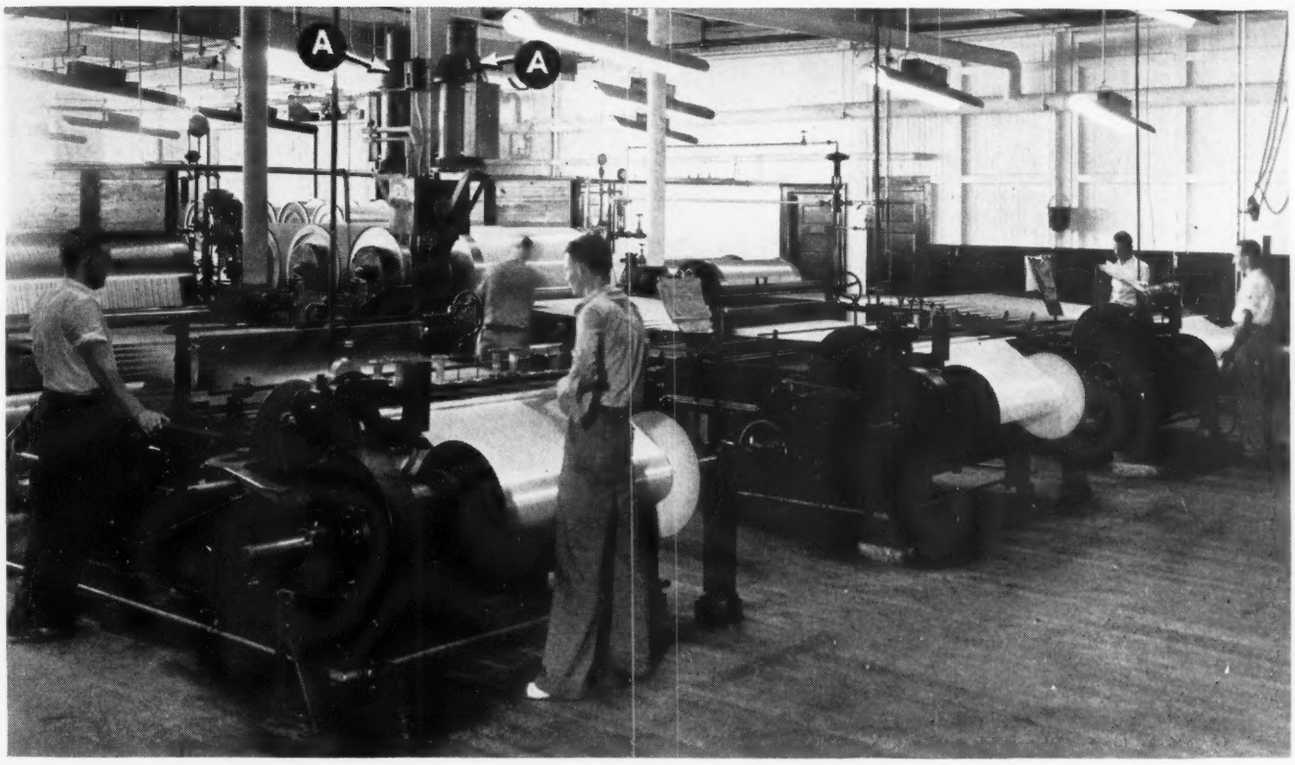


Fig. 7—This group of rayon slashers has a production range of 2.5 to 62.5 rpm from voltage-control units *A* mounted on a building column where they do not in anyway interfere with the production setup

fact that the control is easily tied in with the control system of the boiler or bank of boilers. For instance, if an increased rate of coal delivery is wanted, the control simply moves the speed-adjusting rheostat in the required direction.

Conveyor Drives

Voltage control lends itself particularly well to driving materials-handling equipment such as conveyors and pumps. The value of adjustable speed for a conveyor drive in a production plant is obvious, it can be kept closely in step with day-by-day changes. Also, it provides smooth, easy acceleration and thus lessens the possibility of conveyor breakage and high maintenance expense.

The use of voltage control on materials-handling equipment used to control volume or mixtures is a relatively new application. Consider a case where several conveyors, or pumps, are delivering material of different specifications to a common mixing belt or a vat. With voltage control, it is possible to provide minute control of the material delivered to the mixture, to change the proportions readily, and to control each material exactly through wholly automatic devices.

Small printing presses offer a real drive problem. When direct current was no longer generally available, small presses could not afford special direct-current drives. In fact, many large presses gave up that versatile drive. Various types of drives were used. These gave a relatively low operating speed and about a 2:1 operating range. The small voltage-control drive makes low speeds available for threading and make-up. It provides smooth acceleration up to the desired operating speeds. It also provides wide operating speed ranges. The "setting up" is accomplished by "jogging." New inks, new materials to be printed, make these features desirable, even necessary. Explosion-proof voltage-control drives can be provided when these are required.

Winder Drives

Winders of various types are closely related to printing machinery insofar as the type of drive required is concerned. The surface type of winder must have a drive that provides low threading and inspection speeds, also a large operating-speed range to take care of a wide variety of materials. Center or shaft-type winders present an added speed-control problem. In addition to providing for these requirements, the speed must compensate for the build-up of the roll in diameter in order to maintain a constant linear speed. Winding problems are not confined to paper, but are found in handling various kinds of foils, films, warp as wound for interweaving cloth, in several other application requiring wide speed adjustment and close speed control.

The voltage-control drive will provide power and speed control to operate practically all types of winders. Its simple control and smooth acceleration make it possible to wind the best kind of roll for various types of uses.

Taping-Machine Drives

Fig. 6 illustrates an application in which wide adjustable-speed range is not utilized. Tape must be carefully wound around a cable and accurately lapped. This means that the rate of travel of the cable must be carefully synchronized with the mechanism doing the taping. Since various sizes of cable are built and any individual cable may vary slightly in diameter, the ratios at which the taping operations proceed cannot be fixed, but must be adjustable for each job. The most important requirement is that taping must be correct during acceleration and deceleration. If the two speeds are not perfectly synchronized there is a resulting "scrap" which represents waste. Application of voltage control to this drive has practically eliminated this loss which could not be avoided with the previous type of operation. Also, the proper synchronization makes a better insulated cable possible, which is a very important factor.

Speaking of Power

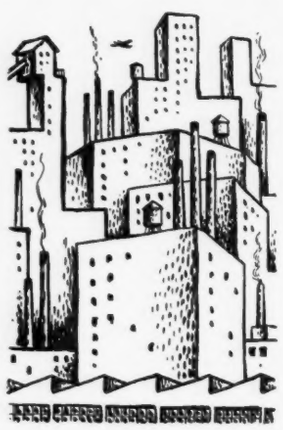
A nice Christmas present for a bunch of exhausted editors

From all indications, POWER'S 33rd Special Section, "Fuels and Combustion", December, 1940, issue, has been as well received by readers as any we have published. So far, requests for over 1200 reprints have been filled, and more are still coming in. Also, visitors at the Power Show three months ago took home 2000 more copies . . . . Of all the requests, we like best the following telegram received two days after the December issue was mailed: "Congratulations on your fuel section. Will you publish this section separately? Please send us 100 copies if available or entire December issue if necessary — Knight Products Inc". . . . A nice Christmas present for a bunch of exhausted editors (recovered now, though).

Just to keep us from getting swell-headed, several people have pointed out two most unfortunate errors on this "Speaking of Power" page (pg 100), January issue. There I paid tribute to two great engineers who had passed away—C F Hirshfeld and Lester P Breckenridge. In the case of Dr Hirshfeld, the name was misspelled. Moreover, the note of appreciation stated that Dr Hirshfeld's death occurred in 1940, whereas, in fact, he died on April 19, 1939. . . . I trust that the many friends of this outstanding power engineer will accept my expression of sincere regret for this carelessness.

A news item in the "Personals" section of this number says that James A Powell has left Reading, Pa., where he was vice-president and chief engineer of E M Gilbert Engineering Corp, to join Stone & Webster in Boston. This news will be of interest to the numerous friends of "Jimmy" Powell. No man in power engineering is more modest and retiring, and none is more worthy of the universal respect in which he is held.

The average newspaper reader these days swings back and forth between the extremes of pessimism and optimism when considering our national-defense program. One day he imagines we are turning out "tens of thousands of planes, tanks, etc". The next he concludes that the defense program is a complete flop. . . . Neither view is justified by the facts. Nobody familiar with the necessities of the situation expected any more rapid defense progress than has been achieved. They certainly did not expect that any great number of planes, tanks or ships would be turned out by this date. In the main, industry has been busy building plants and making machinery with which to make defense equipment. What else could be done? . . . Having visited many factories both in Europe and America, I have no doubt of our ultimate ability to surpass any country in the world in mass production, but even in America it takes a little time to get started. . . . Watch for enormous increases in defense production in the latter half of 1941.



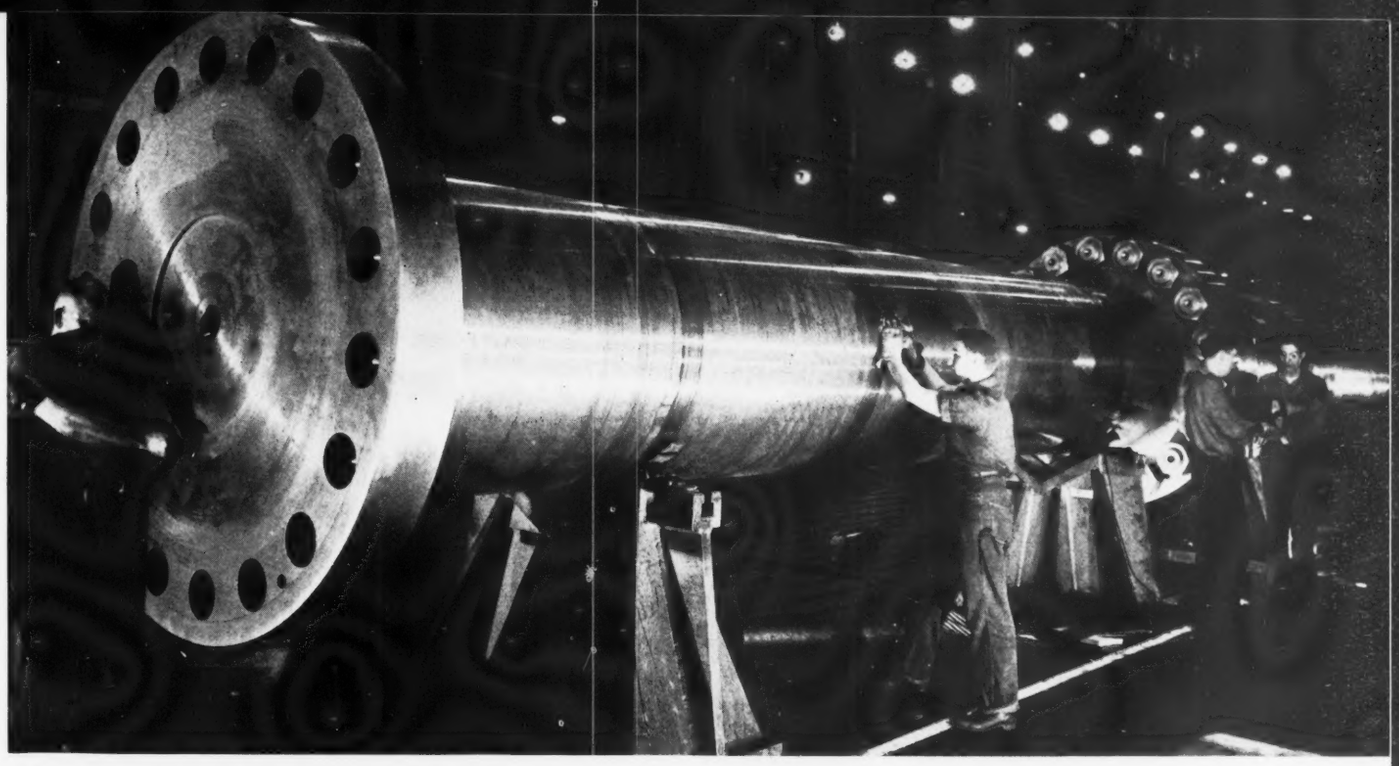
Industry has been busy building plants and machinery

I have just reread a Newcomen Society paper presented some time ago by Dr C C Williams, president of Lehigh University. Under the title of "Decisive Inventions vs Decisive Battles", Dr Williams makes a good case for his claim that the greatest inventions have changed the world more than the greatest battles. . . . His 15 decisive inventions are the lens, gunpowder, magnetic compass, printing press, blast furnace, steam engine, power loom, electric dynamo, grain reaper, engine lathe, telegraph, internal-combustion engine, electric lighting, photography, radio. . . . Think what the world would be without these —and, incidentally, note that several of these inventions are closely associated with power generation and power application. . . . Personally, I would be inclined to add the steam boiler to the list.

"Decisive Inventions vs Decisive Battles"

Next month marks an important milestone in POWER's history, for a quarter century ago, on the last week in April, 1916, Associate Editor Fred A Annett joined the staff, and if anybody wants to know what a real bulwark is, just meet and talk to Fred for five minutes. . . . We are planning an appropriate celebration of the event, for if ever a man has been an inspiration to his associates by his constant good humor, his unflagging zeal for truth and knowledge, his patience and gentleness of spirit, Fred Annett is that fellow. . . . We know that all his many friends will join us in congratulating him on 25 years of real service.—*PWS.*

An important milestone in the history of POWER



This shaft for the Grand Coulee generator is the largest ever assembled at the Westinghouse shops. It is 56 ft long, weighs 150 tons and had to be made in two sections for shipment

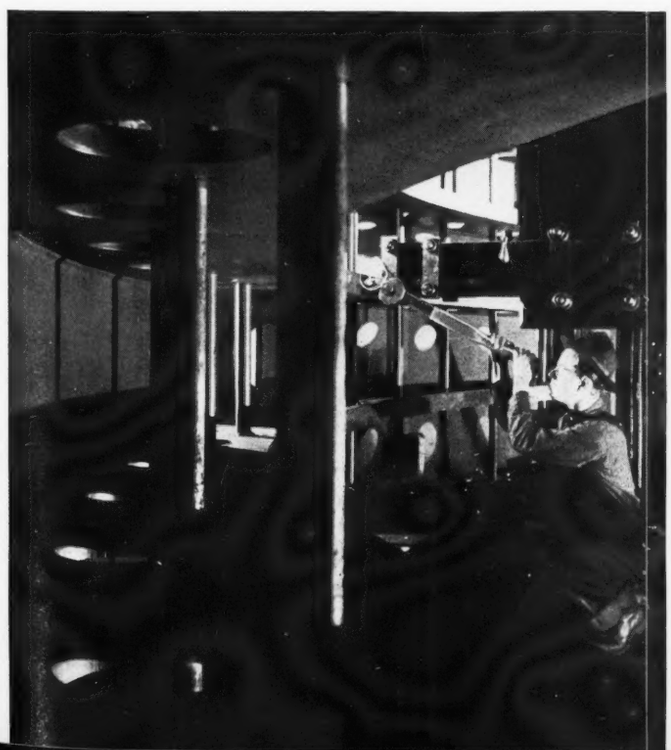
First Generator for Grand Coulee

► A FEW DAYS AGO the world's largest waterwheel generator began its journey westward from the Westinghouse shops in East Pittsburgh, Pa., to the Columbia River in Washington where it will become part of the Grand Coulee hydroelectric project.

This giant machine weighs almost 1000 tons, is 24 ft high, 45 ft in diameter, required 38 freight cars for shipment of all its parts, and is the first of three now being built. A second generator will be shipped early this spring and the third sometime this summer. All three main units and two 12,500-kw service units are scheduled for operation by the spring of 1942. The Newport News Shipbuilding and Dry-dock Co is making the three 150,000 hp waterwheels.

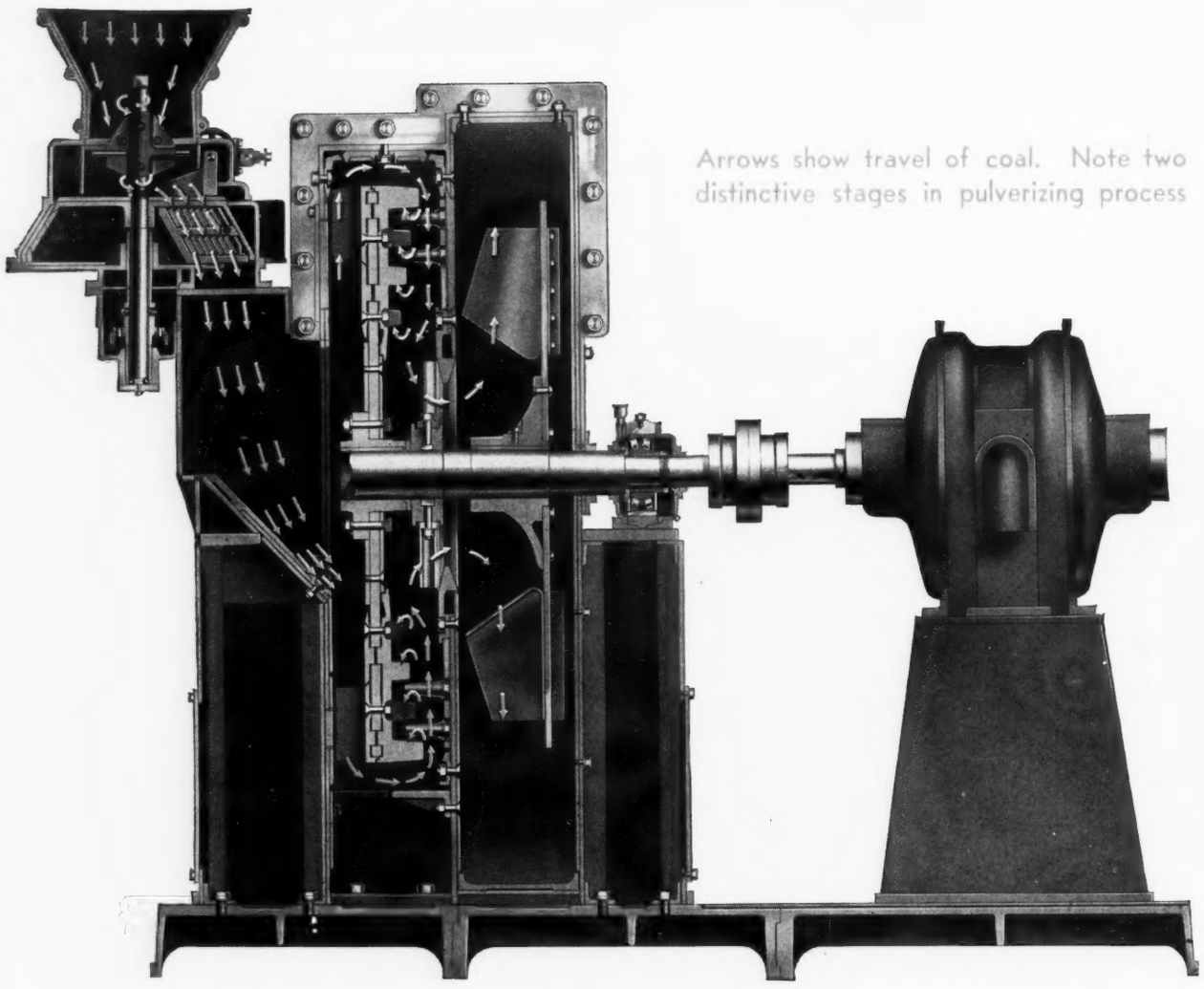
The Grand Coulee power plant is laid out for 18 large generators, each driven by a 150,000-hp turbine, and three service machines driven by 14,000-hp turbines, making an ultimate capacity of 2,742,000 hp—the largest power installation in the world.

Part of the stator winding; over 100 miles of heavy copper wire were used for this particular job



Stationary frame for the 108,000-kw generator has an outside diameter of 45 ft. Photo shows the frame being machined

The New Riley Pulverizer



Arrows show travel of coal. Note two distinctive stages in pulverizing process

These well-known Companies recently installed Riley Pulverizers

Hartford Electric Lt. Co., 4th repeat order—Potomac Electric Power, 3rd repeat order—Union Electric Co., 3rd repeat order—United Illuminating Co.—Conn. Power Co., 2nd repeat order—Interstate Power Co., 2nd repeat order—Central Ohio Lt. & Pwr. Co.—General Electric Co., 4th repeat order—Celanese Corp. of Amer., 3rd repeat order—Carnegie-Ill. Steel Co., 3rd repeat order—Shell Oil Co., 4th repeat order—Curtiss-Wright Corp., 7th repeat order—Winchester Repeating Arms Co., 2nd repeat order—Standard Oil Co. of Ind.—Union Oil Co.—Crown Cork & Seal Co., 2nd repeat order—Henry Disston & Sons—Kellogg Co.—St. Croix Paper Co., 3rd repeat order—Cliffs Dow Chem. Co.—Tri-State Power Corp., 2nd repeat order—Scovill Mfg Co.—American Viscose Co.—Univ. of Minn., 3rd repeat order—Lynn Gas & Elec. Co.—General Motors Corp., 2nd repeat order—Union Public Service Co.—American Car & Fdy. Co.—Wheeling Steel Co., 2nd repeat order—Tenn. Elect. Pwr. Co.—National Cash Register Co., 4th repeat order—Beechnut Packing Co., 4th repeat order—Agfa Ansco, 2nd repeat order—Worcester Salt Co., 3rd repeat order.

TRADE MARK Rx REGISTERED

RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Tacoma Baltimore Milwaukee Denver
St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta Memphis New Orleans

It will pay you to visit modern Riley Installations

lower power consumption

With Riley Pulverizers, pulverization of coal takes place in two stages. The first stage reduces the coal to a fine granular state and the second stage pulverizes the coal to the desired fineness. This two-stage principle of pulverization, together with low no load power explains the low power consumption of Riley Pulverizers. Now improvements have further reduced the power per ton at maximum loads 13.4%.

higher fineness

Change in design has also brought about increased fineness of pulverization. When pulverizing 14% moisture 56 grindability Illinois coal, fineness through a 50-mesh screen was increased from 98.5% to 99.6% and through a 200-mesh screen from 70% to 76%.

greater capacity

Capacity tests conducted on the same coals at the same plant before and after the installation of the improved design has shown increased capacity of over 25%.

lower maintenance

Through a change in coal distribution, the use of new alloys and the increase of 49% in the effective wearing areas of pulverizing parts, longer life is obtained from the parts, not only reducing maintenance but materially increasing periods between shut-downs for part replacements.

greater reliability

The more rugged construction of the pulverizing elements assures even greater reliability. Plant after plant has operated Riley Pulverizers for years without outages because of mill performance. The speed with which repairs can be made also increases the operating availability.

These characteristics have been retained . . . .

FLEXIBILITY—WIDE LOAD RANGE. Because a change in rate of coal feed gives an instantaneous change in coal output widely fluctuating loads are easily carried. Load ranges of 10 to 1 are carried at many Riley installations.

SUSTAINED FINENESS OF PULVERIZATION. Because wear of pulverizing elements occurs in such a manner as to but slightly reduce the effective area of pulverizing elements, fineness of pulverization is well sustained.

QUIET VIBRATIONLESS OPERATION. It is generally conceded and recognized that the Riley Pulverizer is the most quiet pulverizer manufactured. At all loads, including low loads, the Riley Pulverizer gives quiet, vibrationless operation.

EASE OF PART REPLACEMENTS. It is easy and simple to make part replacement and but little time is required to do so. Complete overhaul of a 24,000 lb. per hour Riley Pulverizer can be made within seven or eight hours.

NO LIMIT TO EXIT TEMPERATURES. Preheated air can be used without tempering. There is no necessity for reducing air temperature as a precaution against explosion or fire. Air temperatures about 600 degrees can and are being used with entirely satisfactory results.

COMPACT DESIGN. The design of Riley Pulverizers is compact, requiring comparatively small space for installation.

EASE OF CONTROL. Only secondary air and coal feed need be adjusted to meet load variations.

EASE OF LUBRICATION—EXTERNAL BEARINGS. All bearings are located outside and independent of the pulverizer housing where they are readily accessible and require oiling but once daily. There are no seals to grease with pressure guns.

A survey of your power plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs

COMPLETE STEAM GENERATING UNITS

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • AIR HEATERS
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • FLUE GAS SCRUBBERS

before purchasing Boiler or Fuel Burning Equipment

Color Comes to Lincoln Park

Procedure for engineers at Lincoln Park (Chicago) Power House since adopting the ASME Color Code Identification of Piping Systems

By LOUIS A ROGERS

If you hear a loud bang, then a zip and a scream
It's prob'ly a leak of high pressure steam,
So follow the colors—WHITE—ORANGE—GRAY
And run in a hurry, don't take all day.

If you hear a shrill whistle like valves opening wide,
It's most likely a blow in the low-pressure side.
Then follow the colors WHITE—ORANGE—BLACK,
And find out the trouble before you come back.

If above the roof a "white feather" is seen
Go look for the line WHITE, ORANGE and GREEN,
Then climb up the ladder and make it right snappy
If you want to live long, and be very happy.

There is vacuum in lines that are WHITE, YELLOW, BUFF,
If the gage reads 10 inches, then that is enough.
If the gage pointer there is near down on the pin
It won't be so long before troubles begin.

City-water is GREEN, gages plainly in sight,
If the pressure goes down, don't perish of fright;
Just step to the phone e'er you're forced to shut down,
And call 'til you reach all officials in town.

If over your head is a report like a shot,
The water entanked up above is too hot.
Then just find a pipe line marked GREENISH and BLUE,
If you start the right pump it will circulate through.

When it's time to blow the big boilers down
You look for the pipe marked with GREEN and with BROWN,
Open slowly the long-handled valves in this line
And watch for the fireman to give you a sign.

There's some water they call the main boiler feed,
In plain terms it's what the boiler will need.
It's pumped to the boiler drum up and in back
Through high-pressure pipe with bands GREEN and BLACK.

The condensate water becomes boiler feed,
That's why, we suppose, the council's agreed
To mark this line too, with bands GREEN and BLACK,
Through which to the tank this hot water flows back.

The make-up is pumped direct from the lake
Must be softened and filtered at pump intake.
It passes a meter and the reading's O.K.,
Then flows through a pipe marked with GREEN and with GRAY.

The make-up is mixed with soda and lime,
And becomes "treated feed" in a very short time.
It flows from the tank through a GREEN, YELLOW pipe
To a filter containing some fine anthracite.

To wash out the boilers and do it just right
Use the high-pressure water line YELLOW—BLACK—WHITE.
Until out of the boiler the water runs clear,
Use plenty of H_2O for there's lots of it here.

If a fire crackles out you must know what to do,
So RED is the color to follow straight through.
Just turn on the water at valve painted RED
And open the windows lest gas kill you dead.

Now don't get discouraged or angry or blue
Because of this thing they call CO_2.
If steady the RED ink pen indicates ten
You're doing as well as the best power men.

On the panel board here, a light flashes RED
There's something gone wrong with combustion, 'tis said.
So look at your fires and do it "toot sweet,"
For it may make a change in the people you'll meet.

On the make-up meter if figures look queer,
Just fly for the tunnel and don't strip a gear.
The return pump's not working, it just blew a fuse
So test and renew it, there's no time to lose.

If all of a sudden there's a skip of lost motion,
You have heard it before and 'twas not just a notion,
A soft pin is sheared in a section of stoker,
And you'll need all the tools including a poker.

If the bell's in the tunnel, come out on the run,
Or you won't rate high with Bradstreet and Dun,
The fireman's in trouble, might be most any thing,
For lest it was bad, he never would ring.

If you hear sudden squeals like a whole herd of swine,
Quick hot-foot it toward that little turbine,
The packing is tight, it needs oil or grease,
So fix it right now or there'll never be peace.

Occasionally, too, there'll be some loud knocks
Arising from under the overflow box.
A dash up the ladder, lift valve a few times,
'Cause maybe the stem in the packing gland binds.

Now if there's a thump, a crack and a snap,
You can bet your boots it's a high-pressure trap.
Get wrenches and tools to take off the head,
For this always happens when steamfitter's in bed.

If you hear a queer noise like a train jumping track
You'd better run fast for the valves painted BLACK,
The pump lost its suction, it's racing like mad,
You must stop it quick or it's going to be bad!

But, when there's a boom like a cannon's loud roar,
You'd better lie down, right flat on the floor,
The boiler's gone up and it AIN'T any more,
And you haven't got time to get out the back door.

THE OLD CHIEF

V – Beginnings of Safety First

Fifth in a series by William Doran, chief engineer, Essex County Sanatorium, Windsor, Ontario. Writing of the inspiration of the past, he has captured much of the human side of engineering that lies beneath the maze of power-plant costs and the wavy lines on paper disks

▶ LOOKING BACK OVER MY EXPERIENCES in the old plant, I recall several industrial epidemics, one of the worst of which was the "booster sign" plague. During that time you simply could not enter a manufacturing plant without encountering blatant signboards everywhere telling you "Keep your head up and PRODUCE!" "If you are a worker, don't loaf," "Get going or get out."

Then there were witty ones like "Be a self-starter, or the boss will be a crank," "When you meet a slacker, kick him where his brains are and hit him where they ought to be," "The rooster crows but the hen delivers the goods," and many others. Some of them, I regret, are quite unprintable. Almost every door had its sign "Keep out—This means you!" and every foreman's desk its "Verbal orders are the bunk."

Curing the Plague

I don't know how long the plague lasted in other places, but one bright day in 1920 I was introduced to a new general manager. His first order to me was to instruct the carpenter to remove every sign in the factory, with the exception of the danger signs around the elevator, taking care that the "Private, Keep Out" signs around his office received first attention. Today, the only signs visible around the place are the very fine, educational safety-first notices.

It wasn't until about 1910 that safety-first and first-aid received much serious consideration from either employer or employees. I have seen a man caught and thrown to his death by an unprotected belt; I have seen a mill girl scalped when her hair was caught in open gears; I have seen a man electrocuted when he grasped the pull-cable of a freight elevator that had shorted in the penthouse. These and many minor accidents would have been prevented by the safety measures that are standard practice everywhere today.

"Sanitary" first aid of the old days

In the old days burns and scalds would take months to heal, poisoned fingers were a regular thing, and eye patches were common in the land. First-aid was up to someone in the tool shop, whether he knew anything about it or not. Usually he did not.

The first time I saw the first-aid kit, it consisted of a dirty wooden box kept on a dusty shelf in a dirty storeroom. It contained a tin of discolored zinc ointment, a jar of vaseline and a mysterious bottle labelled "Dutch drops." What the latter were good for I never discovered, as it was always empty.

If you had the misfortune to have a mote in your eye, Big John the machinist was the man to see. He could could turn an eyelid with his dirty fingers and a used match as quickly as a cowboy could rope a calf, and he did it with the same degree of gentleness. And, of course, I must not forget that in a locker in the manager's office there was always a bottle of whiskey which was regarded as ample protection for any real emergency.

Although the incident that follows has nothing to do with accident prevention, it bears telling because of the smile it may bring. When the engineer of today wants to drill holes on the job, he picks a high-speed, light-weight electric drill and experiences no more trouble than he would have at a drill press.

In the old days we used a heavy mandrel with a swinging arm which had to be bolted somewhere in line with the job. We then went to work with a ratchet drill operated by a strong arm. The prescribed method of keeping the drill point cool was a well-directed stream of tobacco juice.

Double Pay for Holes

I remember that during some alterations in the old plant there were about 160 holes to be drilled in panels and channel irons throughout the job, so the manager hired a bright youth to ratchet the holes through at 10 cents per hole. Every evening a bespectacled clerk would come down from the office and mark with yellow chalk the daily crop of drilled holes. Then the youth would take the clerk through various long and dirty tunnels and bring him out in view of the other side of the same holes, which would also bring 10 cents and the official yellow chalk mark.

On my last visit to the old plant I could not help noticing the change in working conditions that the years had brought. I saw the white tiled showerrooms and chrome-plated soap dispensers; the individual metal clothes lockers; the bright, stainless-steel cafeteria; the efficient and sanitary first-aid station, under the care of licensed first-aid man; and best of all, the men were working 40 hours a week, in contrast to the 84 we were used to.

I would like to think that all these improvements in working conditions have come in gratitude and as a reward and tribute to the loyal service and sweaty toil of the old-time power engineers and firemen.

Lubricating Cylinders of Reciprocating Air Compressors

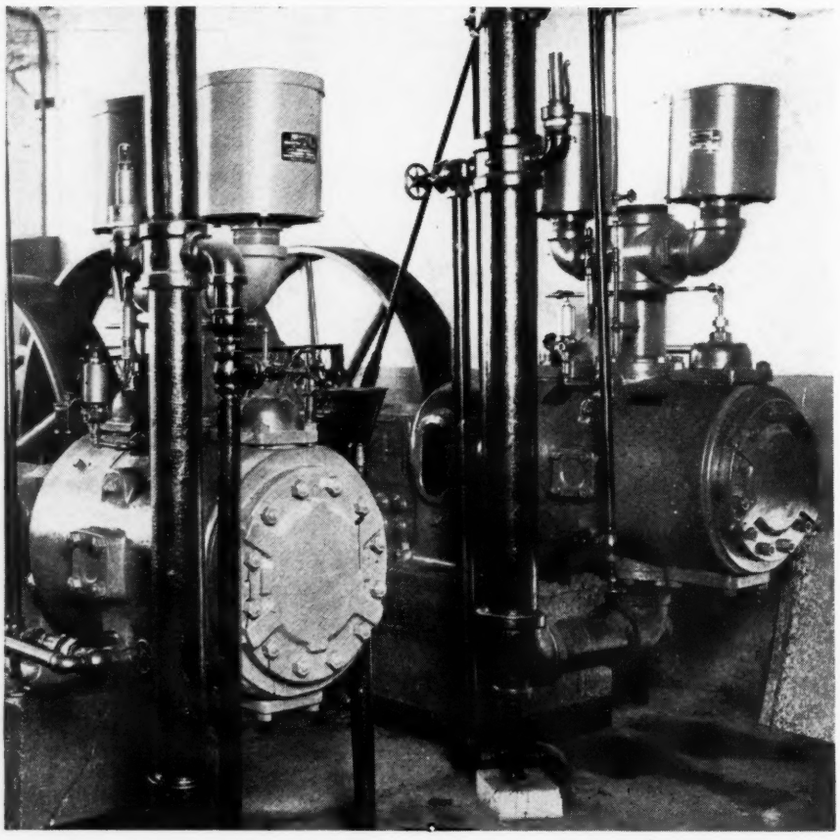


Fig. 1—Thorough cleaning of compressor intake air with an air filter pays dividends

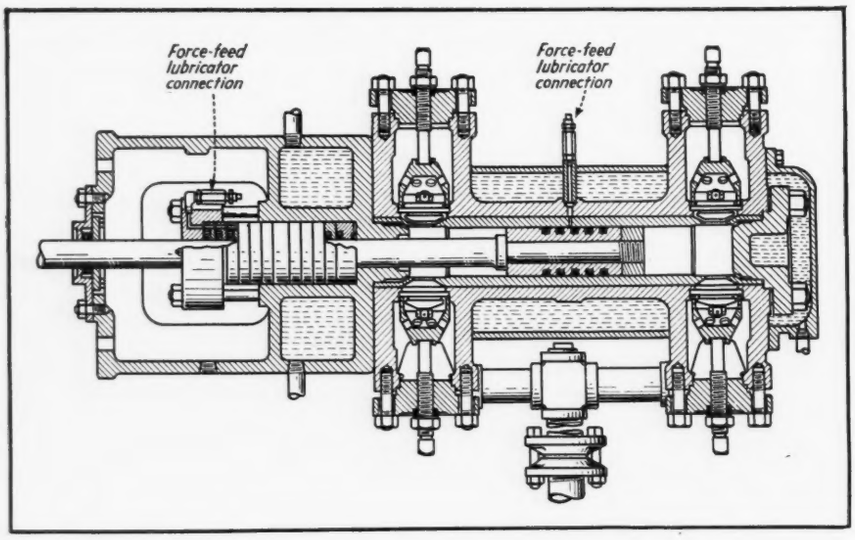


Fig. 2—Forced-feed lubrication applied to the high-pressure cylinder of a compressor designed for 1200 to 2000 lb per sq in.

The author of "Lubricants and Lubrication", a best seller in its field, discusses the various factors and precautions that insure an A-1 lubrication job on air-compressor cylinders

By JAMES I CLOWER

Associate Professor of Machine Design
Virginia Polytechnic Institute

▶ BECAUSE COMPRESSED AIR is used in virtually all industries and under widely different conditions, several types and many sizes of compressors are manufactured. From a lubrication standpoint, however, they may be classified as reciprocating, rotary and centrifugal. These types vary widely as to their lubrication requirements. In this article we will deal only with the cylinder lubrication of reciprocating machines.

Regardless of the make, construction, and operating conditions, lubrication of reciprocating-compressor cylinders resolves itself into a consideration of the piston, cylinder walls, piston rod, and the valves (if poppet or Corliss).

Exacting Requirements

These internal parts are much more exacting in their lubrication requirements than are the external parts. Oil for the former must render three definite services: minimize wear, reduce friction, and provide a tight seal between piston rings and cylinder walls.

Effectiveness of cylinder lubrication depends chiefly on cleanliness of intake air, cooling-system efficiency, method of oiling, characteristics of the oil, and compressor operating conditions.

Atmospheric air is never clean. In it are found various solids (many of which are often abrasive), harmful gases, and water vapor. Smoke, a very common air impurity, generally con-

tains some sulphur-dioxide, carbon-monoxide, sulphuric-acid fumes, and solid carbon particles. Many of these are very reactive with unsaturated hydrocarbons often present in lubricating oils.

Impurities that enter a compressor cause excessive wear and friction and combine with the cylinder oil to build up so-called carbon deposits, which interfere with the operation of valves and rings, clog air ports, increase temperature of the discharged air, and decrease compressor efficiency generally.

More air-compressor operating difficulties are caused by dirty intake air than any other single cause. Thorough cleaning of the intake air with the best obtainable air filter pays large dividends.

Removing Heat

The work done in reducing the volume and increasing the pressure of air within a cylinder is converted into heat. This heat must be removed from the cylinder in order to prevent overheating. It is impracticable to remove all of this heat as rapidly as it is generated; consequently, the temperature of the discharged air ranges, under normal conditions, from 200 to 350 F. Normal operating conditions, however, are never certain because there are several factors constantly tending to cause overheating. These are: too warm intake air, too warm cooling medium (water or air), insufficient amount of cooling medium, overloading or forcing the compressor beyond its designed capacity, leaky discharge valves, deposits in the cooling-water jacket or on air-cooling fins.

Check these factors before placing the blame of faulty operation on the cylinder oil. Effective cylinder lubrication can be obtained only when the cylinder-wall temperatures are low enough to preclude vaporization of the oil film. Guard against discharge-valve leakage, for the recompression of hot discharged air will quickly heat the cylinder walls and overload the cooling system, with the resulting possibility of fire or, in extreme instances, explosion.

The cylinders of reciprocating compressors require a sparing but uniform oil feed. The method of application must be such that the supply can be reduced to the small amount necessary but at the same time remain unfailing. Generally, lubrication is provided by mechanical force-feed oiling, splash oiling, or drop-feed oiling, by one or a combination of two of these methods.

Force-feed oiling, which employs a mechanical force-feed lubricator, makes it possible to feed a measured amount of oil to the cylinders at a rate proportional to compressor speed. The feed can be accurately adjusted and maintained regardless of the volume of oil in the lubricator and temperature fluctuations. Certain of these lubricators can be timed to deliver oil between the rings (see "Timed Lubrication," POWER, May, 1940). Such timed delivery results in efficient oil distribution, insuring a possible minimum oil feed. Force-feed oiling is the most reliable and efficient means of applying oil to a compressor cylinder.

Generally, for small and medium size horizontal compressors, a single lead at the top center of the cylinder is sufficient. For large horizontal units it may be advisable to provide two leads spaced around the cylinder midway of the stroke, and, in some of these units, it may also be necessary to provide a lead to the piston-rod stuffing box (see Fig. 2). Where more than one lead is provided, a multiple-pump lubricator should be used so that each lead can be individually adjusted to its requirements.

Many of the older compressors have so-called pressure drop-feed oilers.

TABLE I—RATE OF OIL FEED FOR AIR COMPRESSORS

Cylinder Diameter, In.	*Cylinder Displacement, Cu Ft*	*Cylinder Rubbing Surface Sq Ft*	*Oil Feed per Cylinder*	
			Drops per Min	*Pints per 10 Hours*
Up to 6	Up to 65	Up to 500	1	0.05
6 to 8	65 to 125	500 to 750	1	0.08
8 to 10	125 to 225	750 to 1100	1	0.11
10 to 12	225 to 350	1100 to 150	1 to 2	0.14
12 to 15	350 to 600	1500 to 2000	2 to 3	0.20
15 to 18	600 to 1000	2000 to 2600	3 to 4	0.27
18 to 24	1000 to 1800	2600 to 3600	4 to 5	0.36
24 to 30	1800 to 3000	3600 to 4800	5 to 6	0.48

TABLE II—SELECTION OF AIR-COMPRESSOR CYLINDER OILS

Discharge Pressure Lb per Sq In.	*Flash point, Deg F*	*Fire point, Deg F*	*Compound, Percent*	*Viscosity, S. U. S.*		
				100 F	*130 F*	*210 F*
Under 150.....	385	440	None	320	143	50
Over 150.....	400	450	0.5 to 1	415	175	54

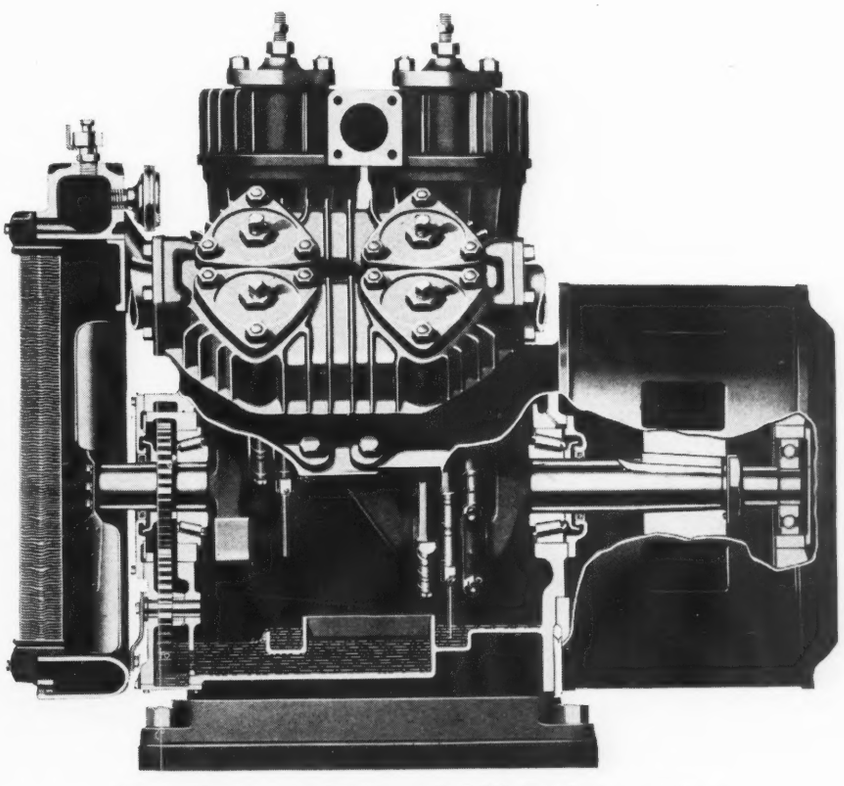


Fig. 3—Vee-type, single-acting, splash-lubricated air compressor

These oilers can not be regulated closely without danger of becoming clogged. The rate of feed is also greatly affected by temperature and oil-level variations.

Splash oiling is widely used for small, vertical, angle, and horizontal single-acting compressors. The connecting rod, or an extension of it, dips into or strikes the oil in the crankcase, splashing it onto the cylinder walls and all other parts. Oil-control rings on the piston are depended on to control oil supply to the cylinder. When the rings become badly worn, or become inoperative because of deposits, or if the proper oil level is not maintained, the quantity of oil entering the cylinder is not accurately controlled.

If the oil level goes too low, the cylinder receives insufficient oil. Too high an oil level over-taxes the oil rings and too much oil reaches the cylinder. In the former case excessive wear and friction result; in the latter, excessive oil consumption and carbon deposits follow. Most of the modern splashed-oil units, however, are provided with troughs and partitions to maintain correct oil level, Fig. 3.

Watch Over-Lubrication

Cylinder oil for compressors should be carefully selected and properly applied. Most operating and maintenance difficulties, such as so-called carbon deposits, sticking valves, compression leaks and high operating temperatures, are often directly traceable to over-lubrication, use of incorrect oil, dirty intake air, or a combination of these. Lubricating oil in a compressor cylinder is not burned as it is in the cylinder of an internal-combustion engine, and, if of high quality, the amount evaporated is practically nil. Only a small amount is required to maintain an effective film on the cylinder walls.

Troubles caused by insufficient oil are seldom encountered. Any increase in the feed above that necessary to provide an effective piston seal and reduce friction to the minimum tends to increase carbon deposits and the danger of fire and explosion. Table I may be used as a reliable guide for determining the amount of oil required. The most reliable method of determining whether or not the feed is correct is inspection of the suction and discharge valves. If the valves are dry or rusted, the feed is insufficient and should be increased, whereas if oil has accumulated in the ports and clearance spaces, the feed is excessive and should be reduced. If all parts show a uniform and just-visible film, the feed is correct.

Air-compressor cylinder oils should be high-quality distillates (not blends) having the highest possible flash point consistent with the required viscosity. They should not contain any cylinder stock, water, sediment, acid, soap, resin, or any other deleterious materials. Where compounded oils are required, the compound should be lard or tallow oil and not rapeseed oil, which tends to oxidize and form gummy deposits under the influence of hot air.

Because of the many different designs and types of reciprocating compressors, one might suppose that several oils would be required for their lubrication. Such is not the case, see Table II—a reliable guide for selecting compressor oils for cylinder lubrication.

The correct oil viscosity is determined by operating temperature, pressure, and mechanical condition of the cylinder. Under normal operating conditions, temperature of the oil film on the cylinder wall is from 125 to 200 F. Viscosity of the oil at these temperatures should be checked closely. If the oil is too thin, excessive wear will result, the piston will not be effectively sealed and blow-by will occur. If the oil is too thick, operating temperature, friction, and carbon deposits increase on valves, piston and cylinders.

Viscosity at low temperatures is of importance when a machine is exposed to cold weather. Under these conditions

(*Continued on page 138*)

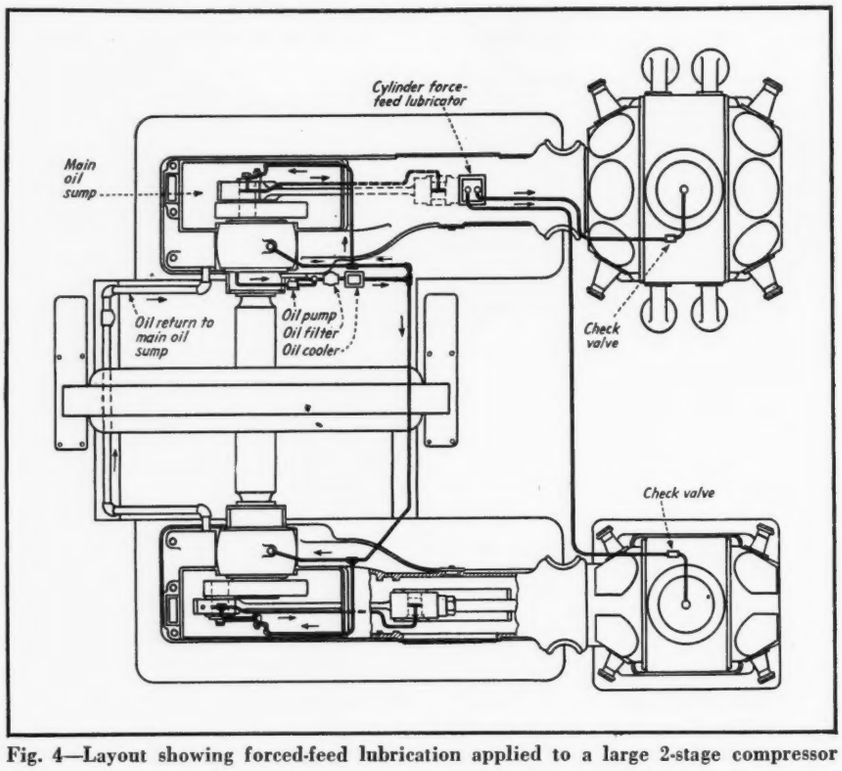


Fig. 4—Layout showing forced-feed lubrication applied to a large 2-stage compressor

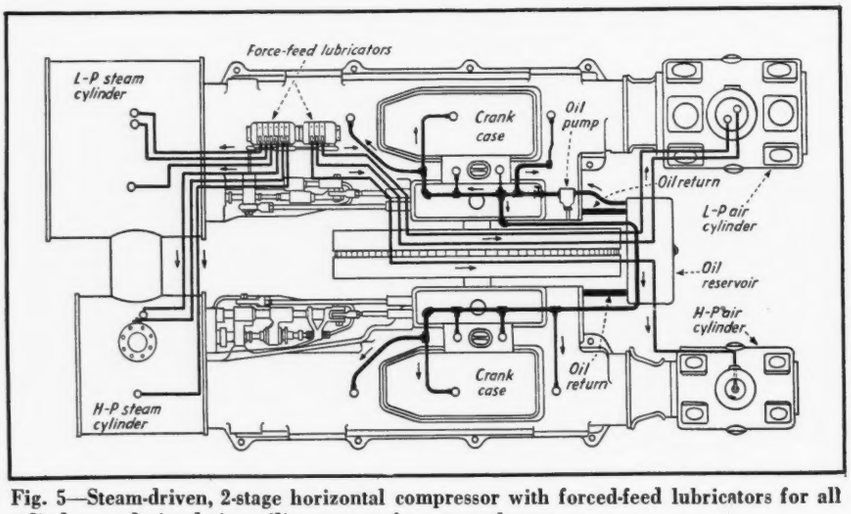
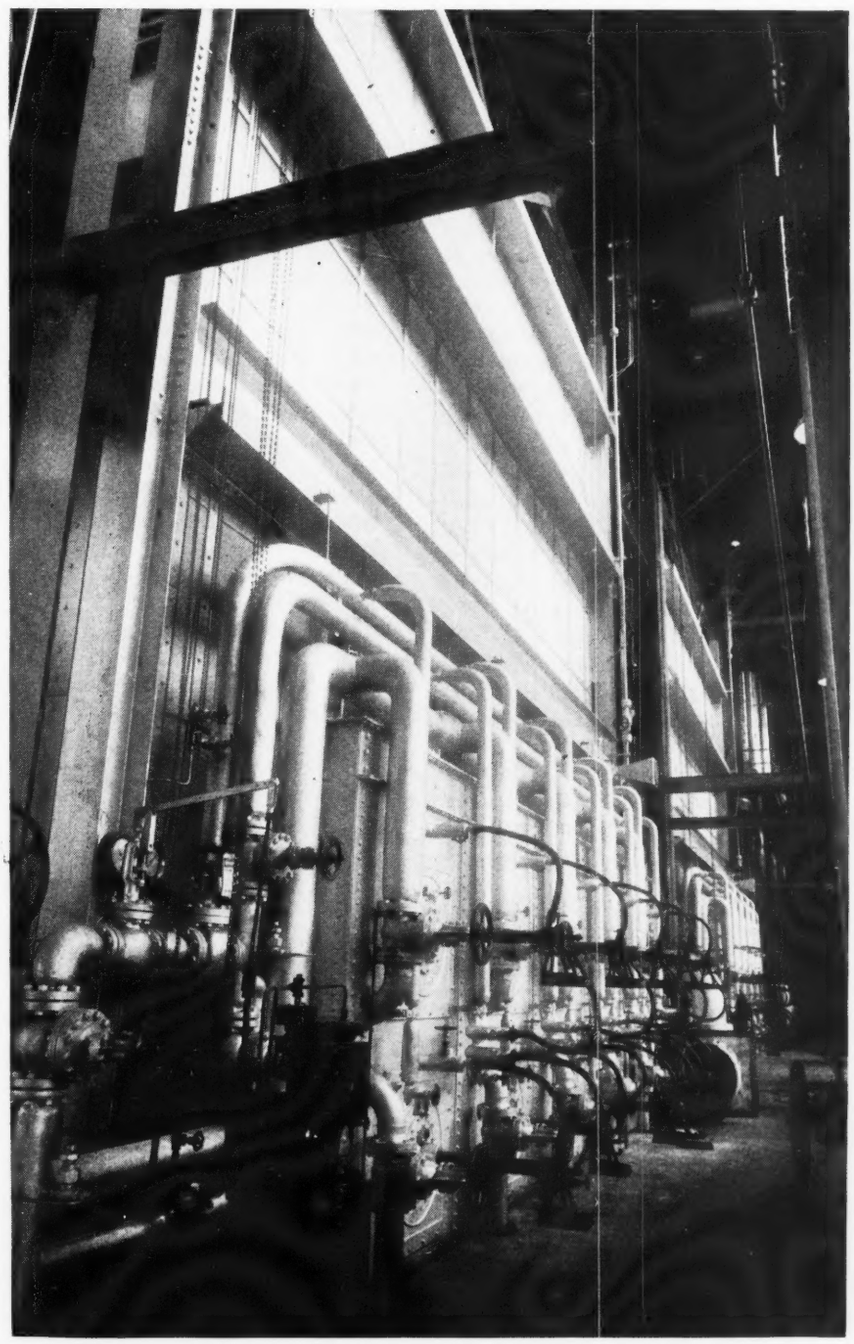


Fig. 5—Steam-driven, 2-stage horizontal compressor with forced-feed lubricators for all cylinders and circulating oiling system for external parts

Conductance Measurement of Condensate Solids

Simple field-test method makes routine check of carryover by removing carbon dioxide and correcting for ammonia. By O K Smith and G T Williams, United Light and Power Service Co



Modern boilers are designed for low carryover so that routine operating measurement of solids requires more exact methods

► IMPROVEMENTS IN DESIGN and more efficient steam scrubbers have enabled boiler manufacturers to make guarantees for very low solids carryover. This has called for development of a more exact method of test. In the latter part of 1938 we started a new method for determining solids in steam, to be used in our plant laboratories for routine control work. This was not only to check boiler guarantees, but also to maintain uninterrupted operation.

As in the determination of solids in boiler water, the natural trend among all companies is toward conductivity measurements. This gives highest degree of accuracy with small amounts of solids.

Dissolved Gases

With this method of field testing there are two vital corrections to be made. These are for the conductance of carbon dioxide and ammonia neither of which affect the deposits which might result from solids carried over with the steam. The amount of carbon dioxide present depends largely on the kind and degree of treatment done at the softener. Whatever portion of bicarbonates have not been removed in softening will result in an equivalent amount of carbon dioxide passing into the system. We are not certain as yet about the source of the ammonia, but some condition in the boiler or the presence of organic matter seems to be responsible for its formation.

More or less elaborate methods have been used or proposed for the elimination of carbon dioxide from samples of condensed steam. Most of these methods do not remove the carbon dioxide entirely but only reduce it to a low value where its effect on the conductivity may be neglected or a correction made.

Earlier workers did not consider tests or corrections for ammonia. Lately, however, it has been found that ammonia may be present in condensed steam samples to the extent of a few

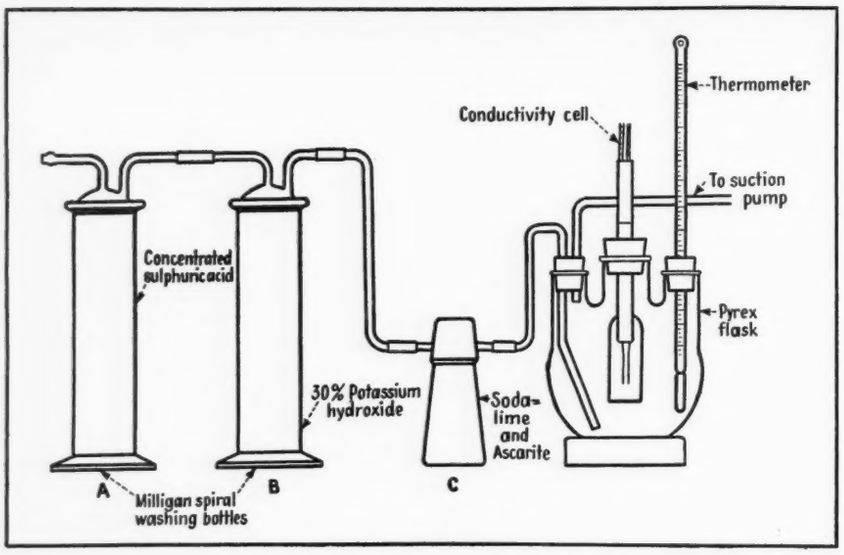


Fig. 1—Apparatus for bubbling air free from carbon dioxide and ammonia through water ample for conductivity test for dissolved solids determination

tenths of a part per million. Dissolved ammonia has a much greater effect on conductance than carbon dioxide and it is extremely difficult to remove such small amounts by any method that will not also increase the conductance.

The object of this investigation has been to develop a practical method for the accurate determination of dissolved solids in steam with corrections for dissolved carbon dioxide and ammonia, which could be used by the average power-plant operator.

Our first assumption was that we would be able to reduce both of these gases to a negligible amount by heating for a short period under a reflux condenser. This procedure reduced both gases to a very low amount, but the conductivity increased due to a slight solubility of salts in the pyrex glass. It was found that any heating operation in pyrex glass resulted in increased conductance, making it impossible to use the method with this type of equipment. It was therefore necessary to make further preliminary experiments.

The experimental work was divided into determining the effect of (1) dissolved carbon dioxide on conductance, (2) dissolved ammonia on conductance, and (3) added boiler water solids on conductance. Attempts were made at first to prepare low-conductivity water for reference purposes by redistilling laboratory distilled water in an all-pyrex apparatus. The best water prepared by this method had a specific conductance of 1.4 michromhos.

Most of the tests were thereafter run with samples of ordinary laboratory distilled water, and the initial conductivity subtracted from all subsequent values to give the conductance due to the added substance only. Conductance was measured by a Leeds & Northrup conductivity meter and dip cell. All readings are in specific conductance in micromhos, corrected to 77 F. All tests were made either at 77 F or close to that temperature and corrected according to Rummel's data.[1] No corrections were made for the conductivity of pure water since it is probably not greater than the experimental error involved. According to Getman and Daniels[2], the specific conductance of pure water is 0.055×10^{-6} at 77 F.

Methods of Testing

Carbon dioxide was determined by titrating 100 ml samples in a tall glass cylinder with 0.00454 normal potassium carbonate solution using ten drops of one per cent phenolphthalein solution as indicator.

Ammonia was determined by direct nesslerization. One ml of Nessler's reagent was added to a 50 ml sample of condensate and the amount of color developed determined with a photelometer. From a previously calibrated curve the ammonia content was indicated in terms of equivalent nitrogen.

The apparatus used is shown in Fig. 1. *A* and *B* are Milligan spiral washing bottles filled with concentrated sulphuric acid and 30% potassium hydroxide solutions respectively. *C* contains soda lime and Ascarite. The dip cell is mounted in a one liter round bottom pyrex flask as shown. When suction is applied to the system, air free from carbon dioxide and ammonia will be drawn through the water in the flask.

The conductivity cell should be of the dip type with a constant of about 0.1. An accurate thermometer, preferably one which may be read to 0.1 F should be used. An ASTM viscosity test thermometer graduated from 70 to 110 F was used for our tests.

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[1] Rummel *Ind & Eng Chem Anal* Ed P319, 1931.

[2] Getman & Daniels, *Outlines of Theo Chem,* 6th Edition, Page 384.

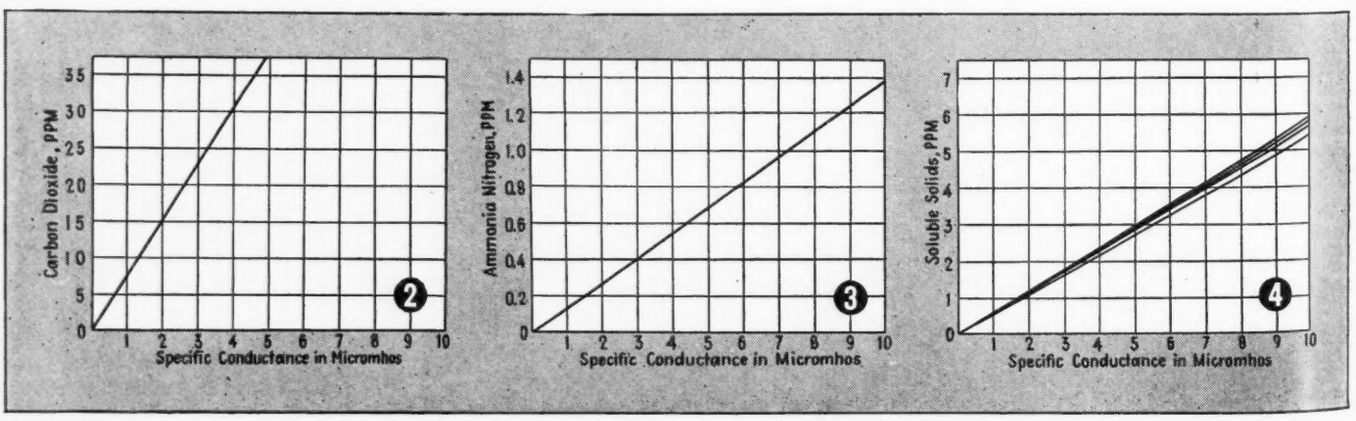


Fig. 2—Conductivity correction for water containing small amounts of carbon dioxide. Fig. 3—Conductivity correction for water containing small amounts of ammonia in terms of parts per million of ammonia nitrogen. Fig. 4—Conductivity of several samples of boiler water containing soluble solids

Carbon dioxide from a cylinder was bubbled through samples of condensate and distilled water. The carbon dioxide content, as determined by titration, was plotted against the conductivity giving the curve shown in Fig. 2. This curve could be used to correct conductivity reading if titrations were made for carbon dioxide. This titration is a difficult one to make, however, as it requires the matching of very faint colors and would hardly be practical as a plant test.

Means for eliminating the carbon dioxide were then investigated. It was found that when a liter of condensate was placed in the flask shown in Fig. 1 and purified air bubbled through for about thirty minutes, the carbon dioxide would be lowered to 1 ppm or less. As may be seen from the curve, this amount will have a negligible effect on the conductance.

Ammonia

When ammonia and carbon dioxide are present in solution the compound formed is ammonium carbamate, $NH_2CO_2NH_4$. The correction for ammonia should therefore be based on the conductance of this compound rather than ammonium carbonate. In order to determine the conductance curve for ammonium carbamate, the following tests were made.

A liter of ammonia-free distilled water was placed in the round-bottom flask shown in Fig. 1 and air passed through to remove carbon dioxide. A known volume of a dilute solution of ammonium hydroxide was added and the increase in conductance noted. An excess of carbon dioxide was added to the solution then purified air passed through until no further decrease in conductance could be obtained and chemical tests showed that there was no free carbon dioxide present.

The conductance of the solution at this point was always greater than before adding the carbon dioxide. The conductance curve for ammonium carbamate obtained in this manner is shown in Fig. 3, the ammonium carbamate being in terms of equivalent nitrogen.

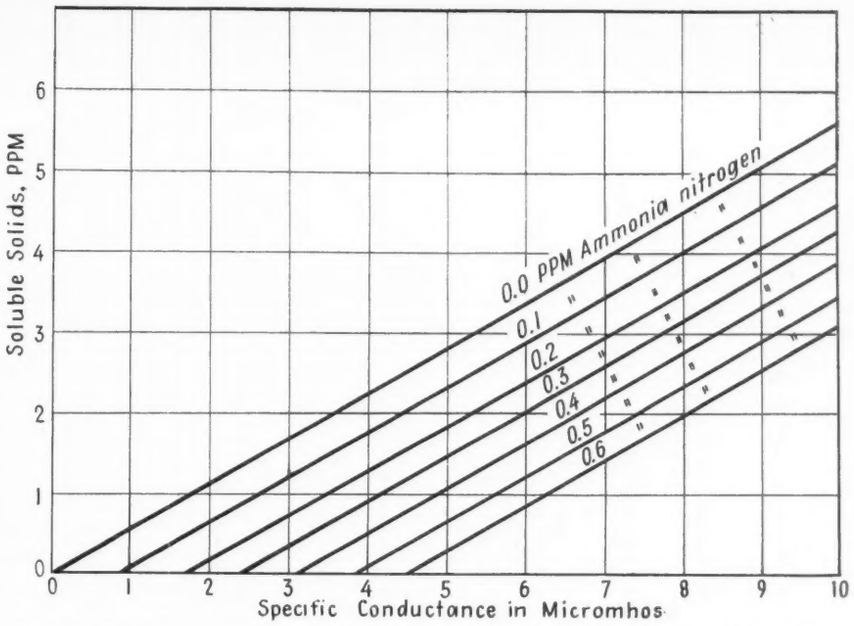


Fig. 5—Curve from which soluble solids may be read directly after carbon dioxide removal and laboratory determination of ammonia content

One liter of distilled water or condensate was placed in the flask and air bubbled through to remove carbon dioxide. Known amounts of a sample of boiler water on which the soluble solids had been determined by evaporation were then added and the corresponding conductivity values recorded. The initial conductivity of the distilled water was subtracted from all values to give the increase in conductivity due to added solids only. Some of the results are shown in Table I and the curve is plotted on Fig. 4. Several samples of boiler water and one synthetic water were used to increase the solids content in the condensate. The composition of the synthetic water is given in the table below:

	ppm
Na_2CO_3	100
Na_2SO_4	325
NaCl	50
Na_3PO_4	25
	500

It has been shown[3,4] that the conductivity per part per million of solids varies with different waters and depends upon the type of solids present. For measuring solids in boiler water it would therefore be desirable to make a curve to fit the particular type of water being tested, but due to the small amount of solids usually found in condensate, the error involved would be negligible and we can therefore use a

(*Continued on page 164*)

TABLE I—CONDUCTIVITY OF DISTILLED WATER

(Known amounts of added solids)

Type of solids	*Conductivity 77 F*	*Solids ppm*	*Conductivity per ppm*	*Average*
Boiler water No. 1	1.72	1	1.72	
	3.42	2	1.71	
	5.10	3	1.70	1.70
	6.67	4	1.67	
Boiler water No. 2	1.75	1	1.75	
	3.45	2	1.72	
	5.20	3	1.73	1.72
	6.80	4	1.70	
Boiler water No. 3	1.83	1	1.83	
	3.72	2	1.86	
	5.56	3	1.85	1.85
	7.41	4	1.85	
	9.16	5	1.83	
Boiler water No. 4	1.79	1	1.79	
	3.50	2	1.75	
	5.28	3	1.76	1.76
	7.01	4	1.75	
	8.82	5	1.76	
Synthetic water	3.67	2	1.83	
	5.54	3	1.85	1.85
	7.45	4	1.86	

[3] Gustafson, H, and Behrman, A S, *Ind & Eng Chem Anal* Ed 11, 355—1939.

[4] Kotto, H J, *Analyst* 63-162—1938.

THE OPERATING ENGINEER

George Edwards
Advisory Editor

Practical Aids
Maintenance Hints
Questions — Answers

Published monthly as an integral part of POWER

How to Make and Fit Piston Rings

Good ready-made rings usually outlast and outperform the home-made variety but when an emergency has you backed into a corner there's nothing to do but "roll your own". From 20 years' experience, afloat and ashore, S M Elonka[1] gives practical pointers on every step in the job

THE OLD SAW that a reciprocating engine or compressor is only as good as its piston rings is a true one and a first-class operating engineer should know enough about this subject to specify the proper rings for each unit under his care, and to design and make his own rings when he can't get the usually superior ready-made product.

Perhaps the most popular method of making rings is to chuck a ring "pot" in the lathe, turn it down to a size anywhere from 3/32 in. to 1/4 in. larger than the cylinder diameter, bore it out to a size that makes a good "stiff" ring and cut the rings off about the width of the piston grooves. The rings so made are usually fitted into the cylinder by cutting enough out of the circumference to leave a small slot when the ring is in place.

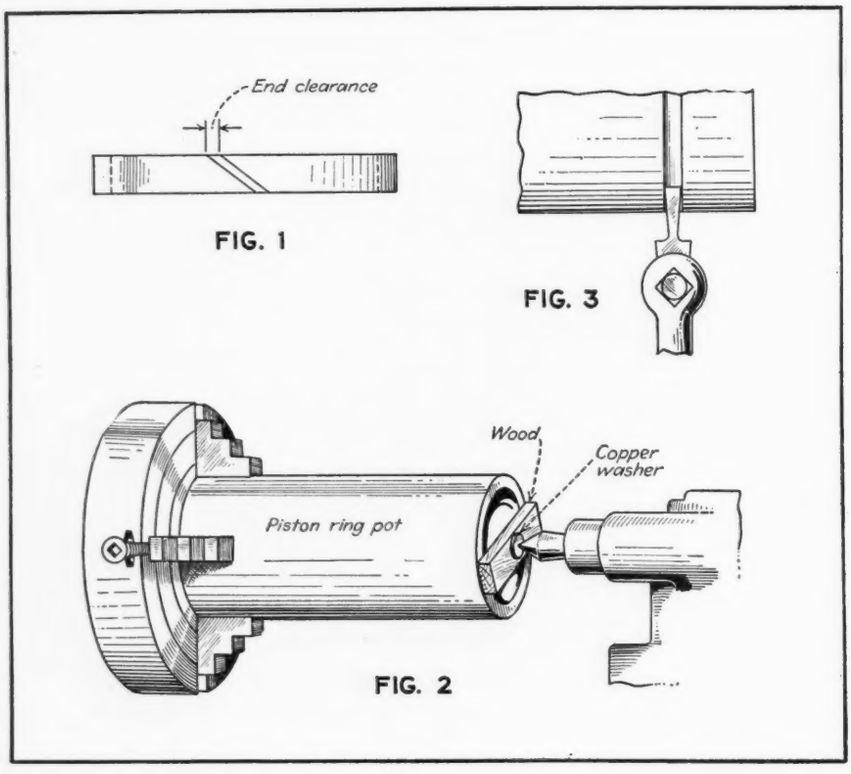


FIG. 1

FIG. 3

FIG. 2

The faults with this hit-and-miss method are too numerous to itemize here, and while the engineer can truthfully say that new rings have been installed, they may be less efficient in maintaining compression than the rings just replaced.

The First Step

The first step in making piston rings involves selecting the proper material. Most ring manufacturers have discontinued machining rings from cylindrical pots and instead cast each ring individually, leaving just enough excess material for machining. Development of the individual casting introduced a higher standard of quality and uniformity than could be obtained with the old pot or cylindrical castings.

However, it is more practical to make home-made rings from pots than to attempt the more difficult individual cast-

[1] Now instructor in Marine Engineering, Metropolitan Vocational High School, New York, N. Y.

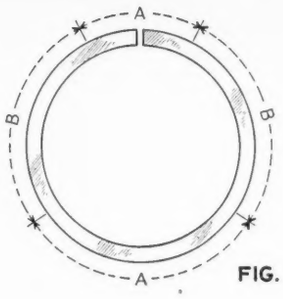


FIG. 4

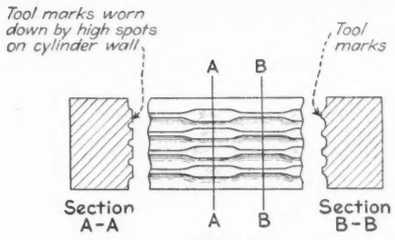


FIG. 5

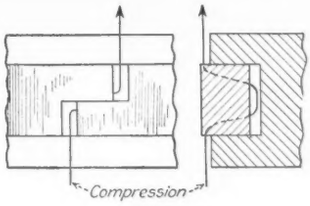


FIG. 6

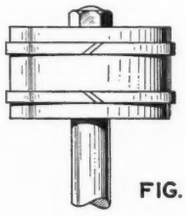


FIG. 7

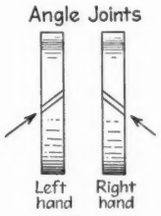


FIG. 8

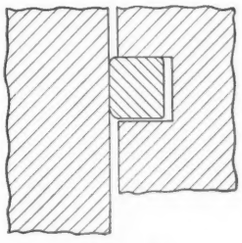


FIG. 9

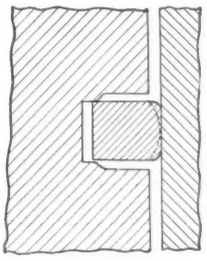


FIG. 10

ing procedure. The pot should be composed of hard, homogeneous, close-grained iron, containing a minimum amount of free carbon. The material should be heat treated at the foundry.

After obtaining a proper casting, the operator must "design" the ring. Whether it is to be a "1-cut" ring, that is, a ring that is not re-turned and re-bored into a true circle after it is split, or a "2-cut" ring, the dimensions and tension should be the same.

Securing Tension

In a home-made ring, tension is secured by turning the ring larger than the cylinder diameter and then collapsing it into the cylinder after a length is cut out. The intensity of pressure between the ring and the cylinder depends on the kinds of material used, the finished radial thickness and the axial width. Since the operating engineer rarely has all this information at hand, he must use a general formula which disregards the nature of the material. Almost every engineer's or machinist's handbook gives a different formula for figuring tension; I believe the following method is both simple and reliable.

Add 0.012 in. for each inch of cylinder diameter, to get total ring diameter. Therefore, in making a ring for a 10.5-in. cylinder, multiply 10.5 by 0.012, which gives 0.126 in. Adding this to 10.5 gives a total of 10.626 in. This will produce a pressure between ring and cylinder wall of anywhere from 2 to 5 lb per sq in., depending on the material and the other dimensions. Some handbooks recommend adding 1/72 of the cylinder diameter, which is about 0.15 in. for a 10.5-inch ring. This may be necessary for poor castings.

The end clearance, shown in Fig. 1, represents the amount of opening the ring has when it is at smallest diameter of the cylinder travel. This clearance is for circumferential expansion. A standard allowance is 0.003 in. per in. of cylinder diameter. Thus, a ring made for a 10.5-in. cylinder will have $10.5 \times 0.003 = 0.0315$ in. end clearance. The same end-clearance allowance is recommended for both steam engines using saturated vapor and for internal-combustion engines. Some manufacturers double the end clearance for rings working in superheated steam.

The end clearance is only part of the amount that must be cut out of the ring. The diameter was increased to 10.626 in. to provide tension, which is the same as saying that the circumference was increased by $0.126 \times \pi = 0.396$ in. This much, plus the 0.0315 in. end clearance, or a total of 0.528 in., must be removed from the circumference to insure a well-fitted ring.

Concentric Snap Rings

Concentric snap rings which are to be sprung over the piston may be made about 1/30 of the diameter in thickness, or about 0.035 *D*. For a 10.5-in. cylinder, this gives $10.5 \times 0.035 = 0.368$ in. or about 3/8 in. A ring of this size is not likely to become distorted or to break when springing it over the piston.

Since rings are usually fitted to old ring grooves, the width of the ring face cannot be controlled by the operating engineer. If new pistons are machined, then the groove widths can be made equal to the thickness of the ring wall. While standard rings are usually a little wider across the face than through the wall, the above proportions will make a serviceable ring if high-grade cast iron is used. For rings from 4 in. to 16 in. diameter, some makers use a face dimension 1/32 to 1/8 in. wider than the ring wall. Piston-ring widths are usually made in even fractions of an inch (3/16, 1/4, 5/16, 7/16, etc) minus a few thousandths for side clearance.

Saturated Steam

For saturated steam, I have found a side clearance of from 0.003 to 0.004 in. to be practical. Some manufacturers recommend 0.006 in. for superheated steam and also for the top rings of diesel engines. The lower rings can be made the same as for engines using saturated steam.

In machining, grind the tool to a blunt point with little clearance or rake and take a heavy cut at slow turning speed. The tool will last longer if the point digs in under the scale, which is usually hard and sandy. Chattering due to overhang can be minimized by running the tail-stock against a piece of wood and a copper sheet washer as shown in Fig. 2. The copper prevents the center from digging into the wood. The pot can also be supported this way while cutting off the rings.

Rings should be cut off through blowholes or sand holes and they should also be split along such spots, thus reducing the effect of these defects. A narrow, square-nose cutting-off tool with sides tapering back from the edge (Fig. 3) does the best job. Locking the carriage to the lathe bed prevents rings from being cut off too narrow

which often happens because the carriage moves toward the ring. Before cutting off, face the end of each ring, using the crossfeed.

After rings are split and the proper amount cut out, it will be seen that the rings are egg-shaped when placed in the cylinder, Fig. 4. The ring will bear against the cylinder along surfaces marked *A* while compression will blow past surfaces marked *B*. This will continue until surfaces *A* wear sufficiently to allow surfaces *B* to seat against the cylinder wall. This is one of the most undesirable features of "1-cut" rings. Other difficulties include wearing cylinders out of round and excessive end clearance when they are finally worn in.

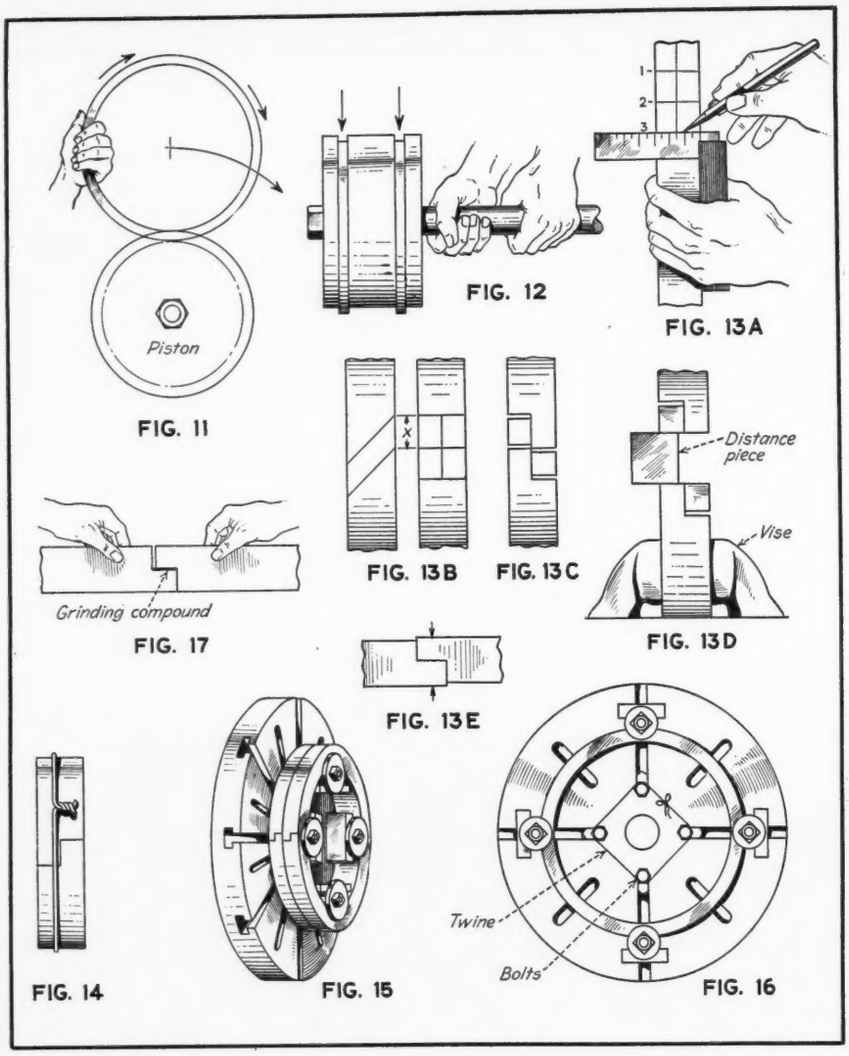
Thin, Flexible Rings

Perhaps the best reason for making thin, flexible rings lies in the fact that they adjust themselves quickly to worn cylinder outlines. Keeping sliding friction between rings and cylinder walls reduced to the lowest possible point for efficient operation is also of major importance. For worn cylinders, the outside of the rings should never be machined or emery-clothed to a smooth finish. By leaving tool marks on the outside face, a more rapid sealing action is secured, as shown in Fig. 5.

Whether piston rings which receive steam at both ends of the stroke are made with an angle or a step cut is of little importance, despite all arguments to the contrary. I contend that saying a step cut makes a perfect seal because the ends overlap is so much eyewash, and submit Fig. 6 to prove it. It can be seen that steam enters the gap on the compression side of the ring, goes under the rings and out into the exhaust end. So long as there is space between the inside of the ring and the groove, compression will leak through the same as through an angle-joint.

Right and Left Hand

Fig. 7 shows a piston with right and left-hand angle-joint rings. Some engineers contend that compression takes longer to leak through because of the change in direction while others believe that the rings will have a tendency to turn on the piston by blowing against each other through the gaps, thus wearing the cylinder round. For lack of data on these theories, I hesitate to hazard any thoughts other than that right- and left-hand joints certainly improve the appearance of drawings. Incidentally, a right-hand joint is one that slopes upward from right to left when the ring is in the vertical position, while a left-hand joint slopes upward from left to right, as in Fig. 8.



Rings made for lubricated cylinders should have the outside edges rounded as in Fig. 9. This causes the ring to slide over the oil film rather than scrape it off. On diesel engines, the lower edge is often left sharp to scrape excess oil back to the crankcase.

The adage that a ring is only as good as its groove should be kept in mind, and unless the sides of the grooves are faced each time new rings are installed there is little sense in replacing rings. Fig. 10 shows a new ring riding on the old shoulders. This puts the ring under severe strain causing wear as shown by the dotted line, and perhaps breakage. The importance of a good joint between sides of ring and groove cannot be overemphasized.

The best way to assure a proper fit is to machine the rings several thousandths wider than the groove, then place the piston in the lathe and face off the groove sides until the ring rolls freely around the groove, as shown in Fig. 11. This assures a better job than obtained by the usual method of facing the grooves first and then filing the ring to fit. To determine the proper amount of side clearance, some engineers hold the piston as in Fig. 12. If rings slide gently to the bottom of the grooves, there is enough clearance, assuming rings have not been sprung out of line in stretching over the piston.

Two-Cut Rings

Experience shows it is well worth the extra time required to make "2-cut" rings instead of the more common "1-cut" egg-shaped variety. The calculations are the same for both types except that from $\frac{1}{16}$ to $\frac{1}{8}$ in., depending on ring size, is left on both inside and outside dimensions for later machining. Rings made in this way should be step cut, or they cannot be clamped properly against the faceplate.

To layout the step, chalk the ring and scribe three lines across the axial width, as shown in Fig. 13*A*. The distance "*x*" in Fig. 13*B* is equal to the total amount to be removed and is the same for either angle or step-cut rings. Split the ring with a hacksaw, through the center line, and saw halfway through from opposite sides as shown in Fig. 13*C*. Fig. 13*D* shows the ring in a vise with a distance

piece holding the ends apart just wide enough to saw out the squares along the vertical center line. File the steps so that the distance indicated by arrows in Fig. 13*E* is slightly greater than the ring width.

Hold rings in the closed position by twisting wire around the circumference (Fig. 14). Fig. 15 shows rings clamped to a faceplate by means of bolts, washers, and distance pieces. A heavy piece of paper between rings and faceplate will protect the latter from the lathe-tool bit. Now it can be seen that a few thousandths left in the step joints will insure rings staying closed while machining. After the rings are trued and clamped securely against the plate, wires can be removed and the outside diameter turned to exact cylinder dimensions.

Next twist wires around rings as before and place another set of clamps around the outside of the rings, opposite the inside clamps. When secure, loosen inside bolts and if they cannot be removed, hold them together as shown in Fig. 16 so they will be out of the way of the boring tool. After rings have been bored to proper wall thickness and removed from the faceplate, the steps can be filed to conform with the ring width. Some engineers grind the step joints with grinding compound to insure a perfect job (Fig. 17).

Rings made in this way will be as nearly perfect as possible and the operator will be repaid by the efficient and satisfactory operation of the engine. It is assumed, of course, that shoulders are removed from cylinders before installing new rings.

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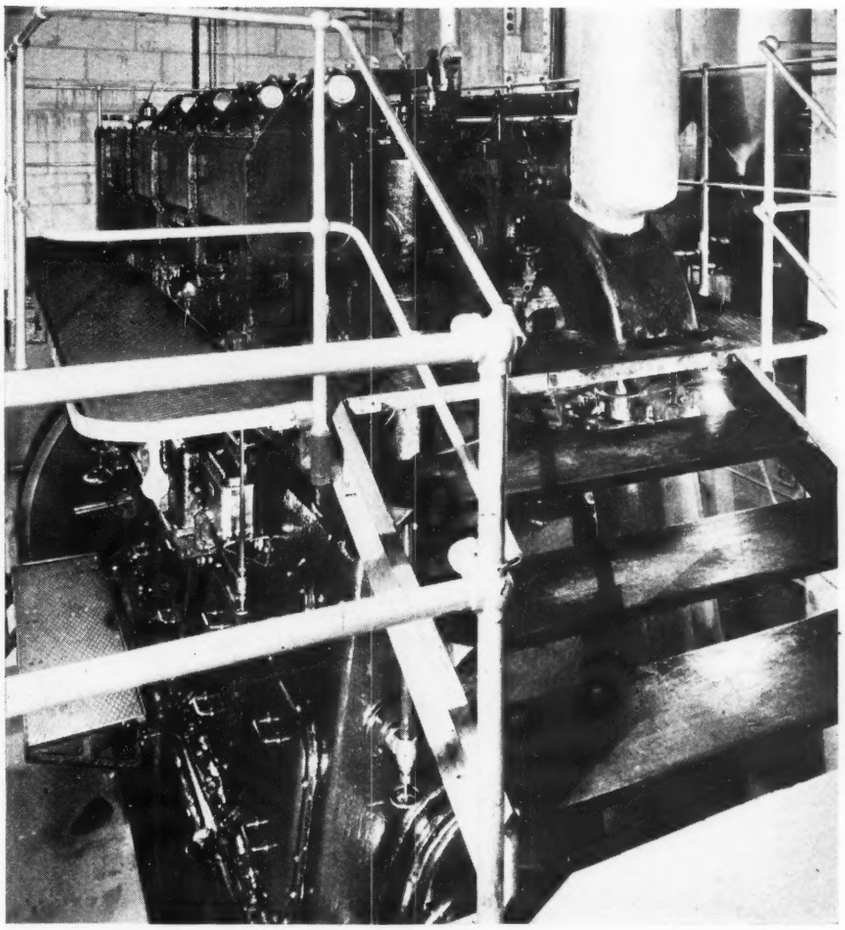
Diesel in a Hole



WHEN FACED with the problem of installing a large diesel in an old engine room with only 11 ft headroom, Chief Engineer Daly of the Minneapolis Chamber of Commerce took the only way out and sank the machine base 7 ft below the existing engine-room floor. It looked bad while it was going in and watchers did plenty of kibitzing, but experience shows this to be a swell idea from the operating point of view.

The operator can see every part of the diesel from the engine-room floor without climbing up and down a nearly vertical ladder slippery with oil; he can see all the water thermometers on the cylinders, the oil-pressure gages, and the exhaust temperatures, without leaving the engine-room floor. When cylinder heads need to be taken off, all the work is done on the engine-room floor, at practically the same level as the cylinders and not 18 ft above floor level up a greasy ladder. These features all add up to greater convenience and time saved. Chief Daly says "We can't see a single disadvantage due to sinking the engine 7 ft down in a 'hole'." See POWER, April, 1940, for a description of this efficient steam-diesel plant.

Telltale Holes Keep Tabs ON INTERNAL CORROSION

Harry M Spring tells how to calculate the depth of telltale holes and how to use them to check up on the inside condition of tanks where inspections cannot be made

ENGINEERS in many plants have to maintain a wide variety of unfired pressure vessels, such as air receivers, digesters, vulcanizers, kiers, autoclaves, and other units. Construction of many of these units comes within the scope of the American Petroleum Institute or the Unfired Pressure-Vessel Code of the American Society of Mechanical Engineers. A number of states have expanded their boiler inspection laws to include many types of unfired pressure vessels.

These regulations, when and where they can be applied, are very helpful in insuring the safety of these vessels. Some tanks, however, either because of their construction or the nature of their contents, cannot be readily inspected on the inside. Then, it is important to have some means of finding out when the shell has become dangerously weakened, either from internal corrosion or other causes. This may be done by using "telltale holes."

These are small blind holes drilled into the shell or head from the outside to a depth equal to the safe thickness of the plate. Then when internal corrosion reduces the plate to this thickness, the bottom of the holes is reached and leakage gives warning of what has happened. These holes are distributed over the area known to be most susceptible to internal corrosion or erosion. Fig. 2 shows a pressure tank drilled with telltale holes in two areas.

There is no set rule for calculating the depth of telltale holes that can be applied in all cases. Individual cases may depend upon local ordinances, material of construction, pressure, contents of the vessel and other factors. A method frequently used is to calculate the safe minimum thickness of the shell of cylindrical vessels subjected to internal pressure by the formula:

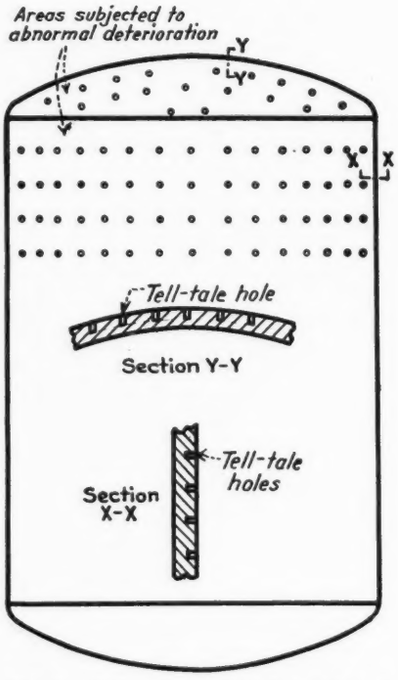


Fig. 2—Pressure tank drilled with telltale holes in two areas

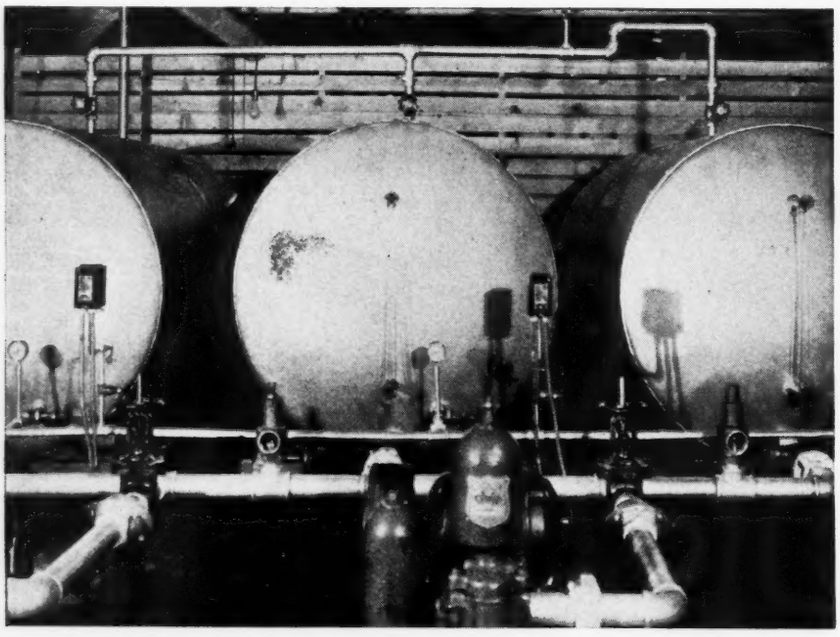


Fig. 1—When pressure tanks cannot be inspected on the inside, telltale holes should be drilled in the outside surface in areas where internal corrosion is most likely to occur

$$t = \frac{PRF}{TE}$$

Where t = required thickness of plate in inches
P = maximum allowable working pressure, lb per sq in.
R = inside radius of vessel in inches, provided t is less than 0.1 R
F = factor of safety
T = tensile strength of shell metal
E = efficiency of longitudinal seam

It will generally be found that the design factor of safety will be at least

5 for most installations of modern construction. If a 3.5 factor of safety is selected as the minimum before the shell of the vessel becomes unsafe because of deterioration, then calculate the shell thickness to give this factor of safety and drill the telltale holes to that depth.

How Deep the Holes?

For example, assume a tank 60-in. in diameter, operating with safety valves set at 200 lb per sq in. The shell is made of steel having a minimum tensile strength of 70,000 lb per sq in., and the longitudinal seam is double-vee welded in such a manner that the ASME Unfired Pressure-Vessel Code would allow an efficiency of 80%. The shell of this tank is 11/16 in. (0.6875 in.) thick. How deep should the telltale holes be drilled to indicate that deterioration has reduced the shell thickness to where the factor of safety is only 3.5?

First let us ascertain the required thickness with a factor of safety of 5 to make sure that the tank shell has sufficient thickness to start with. The pressure P is 200 lb per sq in.; the radius R of the tank, $60 \div 2 = 30$ in.; the factor of safety F, 5; the tensile strength T, 70,000 lb per sq in.; and the efficiency E of the longitudinal seam, 0.80. Then the shell thickness is:

$$t = \frac{200 \times 30 \times 5}{70{,}000 \times 0.80} = 0.535 \text{ in.}$$

The shell is actually 0.6875 in. thick; therefore, its factor of safety exceeds 5, which requires only 0.535 in. Now, the shell thickness required for a factor of safety of 3.5 is

$$t = \frac{200 \times 30 \times 3.5}{70{,}000 \times 0.80} = 0.375 \text{ in.}$$

This value 0.375 in. (3/8 in.) is the minimum depth of the telltale holes. Since the shell is 0.6875 in. thick it can corrode on the inside to a depth of $0.6875 - 0.375 = 0.3125$ in. before its thickness is reduced to the minimum safe value. At this point the bottom of one or more of the telltale holes will be reached and the tank will start to leak.

The minimum required thickness of a dished-out head is found by:

$$t = \frac{PRF}{T}$$

where R equals one-half the radius in inches to which the head is dished, and F equals 8.33 the minimum design factor of safety for dished heads. Other factors are the same as in the first formula.

Assume that the heads of the 60-in. tank are 7/8 in. (0.875 in.) thick and made of steel having a tensile strength of 70,000 lb per sq in., dished to a radius of 60 in. Then the minimum design thickness of the heads is:

$$t = \frac{200 \times 30 \times 8.33}{70{,}000} = 0.714$$

The thickness of the heads, 0.875 in., is therefore on the safe side. Then, if a minimum factor of safety of 5 is permitted in operation, the thickness of the heads may deteriorate to:

$$t = \frac{200 \times 30 \times 5}{70{,}000} = 0.428 \text{ in.}$$

which should be the minimum depth of the telltale holes.

The diameter of telltale holes is arbitrary. However, they should not be too small or slight leakage may block the holes and defeat their purpose. A size commonly used is 3/16 in. in diameter.

This same process may also be used to check the safe thickness of a dubious tank. First calculate the minimum safe thickness of the shell and heads and then bore to that depth in the suspected areas. If the holes do not pierce the shell you know that the minimum safe thickness has not been reached.

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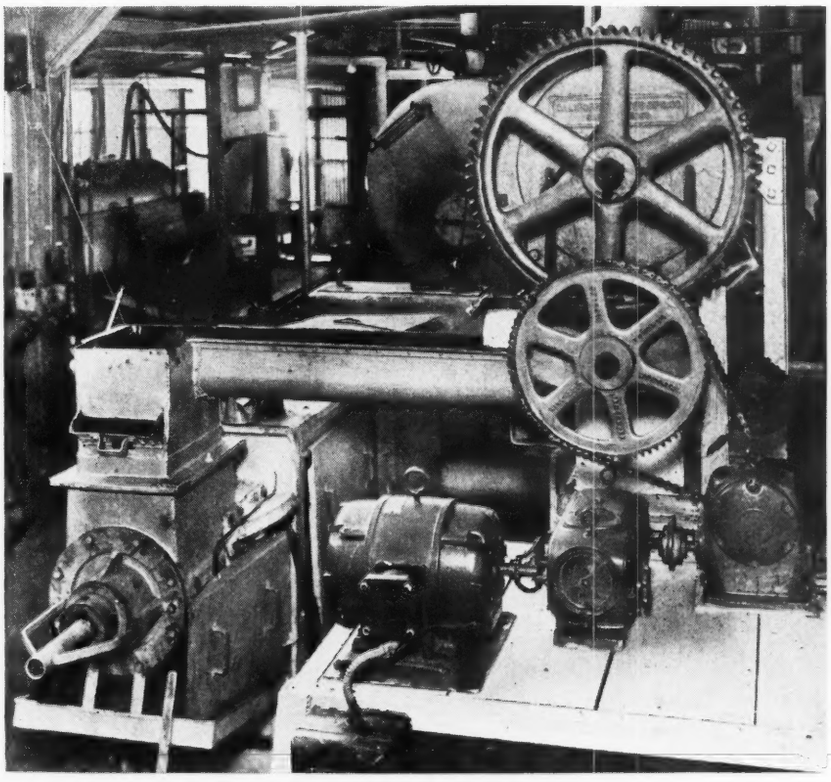
1000 to 1 Speed Range

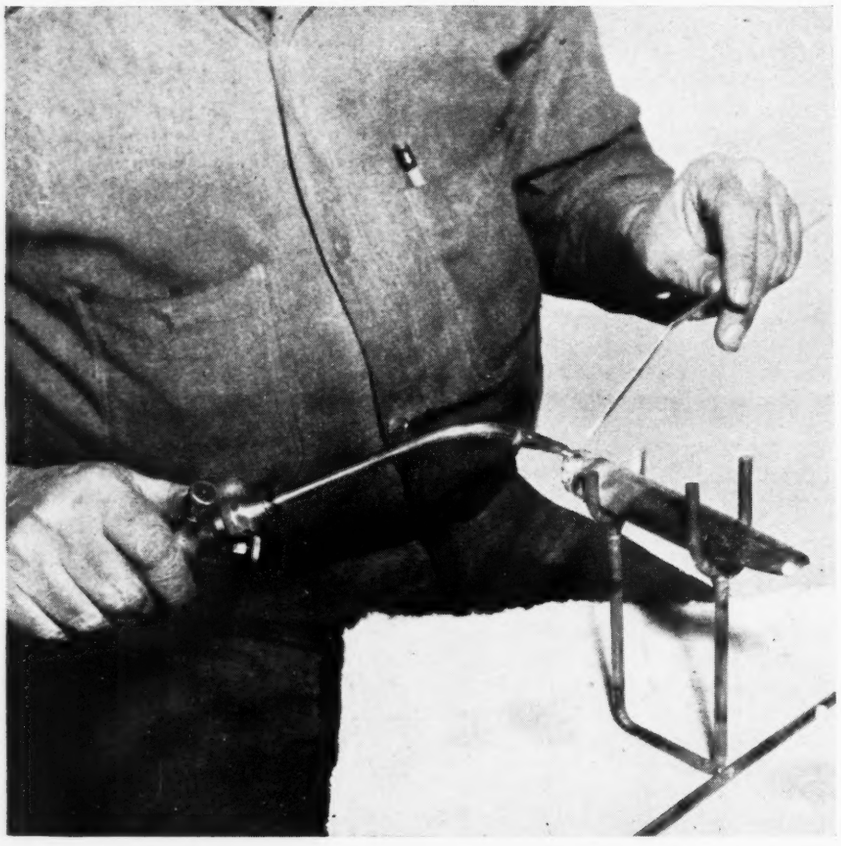


▶ MANY POWER APPLICATIONS require not only very low speeds but wide speed ranges as well, as in this fish-cooker drive. Here the power source is a 3-hp, 1760-rpm, totally enclosed Canadian Westinghouse motor. A 17-tooth pinion on the motor shaft connects by a roller chain to a 35-tooth sprocket on the input shaft of a 3:1 variable-speed unit.

The output shaft of this latter machine couples directly to the worm shaft of a worm-and-gear speed reducer (11.66 to 1 ratio). A roller chain with a 17-tooth pinion and an 80-tooth sprocket brings the drive to the cooker. A 14-tooth spur pinion on the sprocket shaft meshes with a 73-tooth gear on the cooker shaft. This arrangement gives a speed range on the cooker shaft of approximately 1.74 to 5.22 rpm.

The maximum speed reduction is 1760 to 1.74, or 1000 to 1. Neglecting the effect of friction, the torque will increase inversely as the speed. All the mechanical-power transmission equipment, except the spur gears, was supplied by the Link-Belt Co.

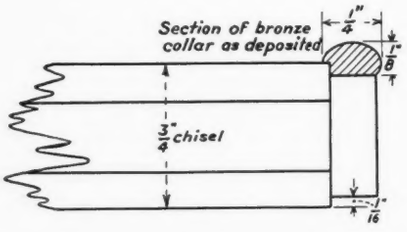
PRACTICAL AIDS TO OPERATION



Bronze-Welded Bands Safe-End Cold Chisels

UNLESS THEY ARE SPECIALLY TREATED in some manner, the striking ends of cold chisels and similar hand tools are apt to mushroom, crack and spall long before the end of the tool's useful life is reached. Working with tools in this condition is dangerous and inefficient. For instance, there is danger of metal chips spalling off and flying away when the end of the tool is struck, causing possible painful and serious injury. A chisel with a spalled end also reduces the effectiveness of a hammer blow and tends to dull the tool more quickly, which does not happen when the striking end is in good condition.

To overcome these difficulties a quick and economical method has been developed for safe-ending these tools. For a new chisel this procedure consists of grinding a shoulder about $\frac{1}{16}$ in. deep and $\frac{1}{4}$ in. long on the striking end of the tool, see drawing. Then, a reinforcing band of bronze is deposited in the



shoulder by means of an oxyacetylene blowpipe, as in the photo. The job is completed by grinding the striking end of the tool square.

On tools having damaged striking ends, first cut the end off to sound metal and then proceed to safe-end as for a new tool. The striking ends of safe-ended chisels wear about 3 times as long as those with untreated ends.

Newark, N. J. H H Moss
Linde Air Products Co

Install Air Receivers Inside the Plant

GOOD PRACTICE DICTATES that air receivers and other non-fired pressure vessels be installed indoors to protect them from the weather. In many instances, however, air receivers are placed out of doors, usually just outside the engine or compressor room.

This is done to save building space; also, in case of a receiver failure, the damage done will be much less than if the receiver were inside. In these installations, unless the receivers are carefully protected with corrosion-resistant paint, the metal in them is likely to corrode and may create an explosion hazard if neglected.

Another disadvantage of having air receivers out of doors is that in cold weather, unless they are kept drained, condensate in them may freeze and cause leakage at the joints. When a receiver with a convex and a concave head is placed in a vertical position its convex head is usually placed at the bottom to facilitate proper drainage. This places the concave head at the top where it forms a basin in which rain water and dirt collects. This water cannot escape except by evaporation. Mixed with acid and other fumes from the atmosphere, this water may become very corrosive and in cold weather may freeze.

Another disadvantage of installing air receiver out of doors is fouling of the safety valves. Here they are subjected to the effects of air, water and atmospheric impurities. If these valves are not given careful attention they may become inoperative, a condition that might easily cause an explosion. Air receivers out-of-doors need more attention, but are likely to get less than when installed inside because of their location.

The disadvantages of installing air receivers out of doors so greatly outweigh the advantages that for most plants they should be placed inside. Where they must be placed outside, they should be placed so that they can be easily inspected and given proper care.

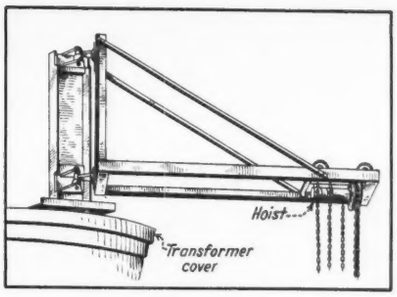
Cleveland, Ohio A R CIOTTI

Defective Pulley Spoils Commutator

A GENERATOR COMMUTATOR gave trouble by wearing out of round. The machine was belt-driven from a steam engine. The commutator would get in such bad condition after two or three months service that it would have to be trued in a lathe. After about one year of this, another armature was purchased and installed. Its commutator also wore out of round in a few months.

Then, the manufacturer's engineer was called in to determine the cause of the trouble. He found the armature shaft pulley running out of round, because the hub had been bored off center. A new pulley corrected the trouble.

Plainfield, N. J. H W HODGSON



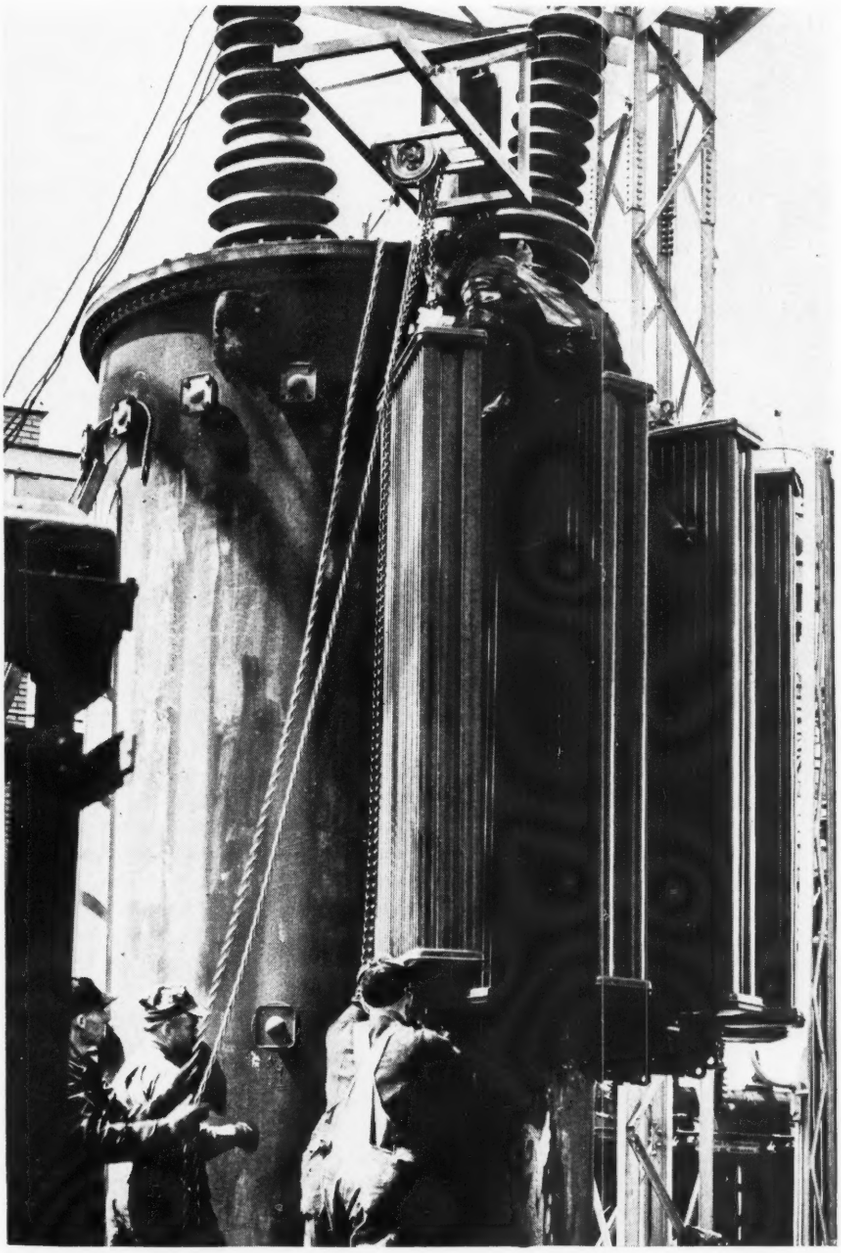
Simple Hoist Handles Transformer Radiators

A DEFINITE POLICY FOR MAINTAINING the cooling radiators mounted on the outside of large transformer tanks is important to the successful operation of an electric power system. The most important factor in this work is to keep the radiators clean, and protected by painting against effects of the atmosphere to which they are exposed. Some radiators can be painted while in place on the transformer.

On the larger units, to perform a good job, the radiators must be removed, which in most cases requires taking the transformer out of service. It must be kept in mind that radiators weigh from 1000 to 1400 lb, and consequently must be handled with care. The simple hoist, shown in the diagram and photo, provides an efficient and safe method of handling radiators, as well as any other part on the outside of the transformer tank. It consists of parts that can easily be handled and set up by two men.

The mounting post is made up of an H-beam, welded securely to a heavy base plate. This assembly weighs only about 50 lb, and the base plate is provided with holes to permit mounting on the transformer tank cover by a few of the cover bolts. A swing crane is attached to the mounting post on bracket bearings welded to the post.

The swing crane weighs about 80 lb, and can be, if necessary, installed by one man. A trolley assembly, a one-half ton special low-head-room roller bearing unit with sufficient chain-length to be operated from ground-level, is placed on the swing-crane arm. This trolley unit weighs approximately 80 lb and it, too, may be handled by a single man.



Guy-Rope Assembly

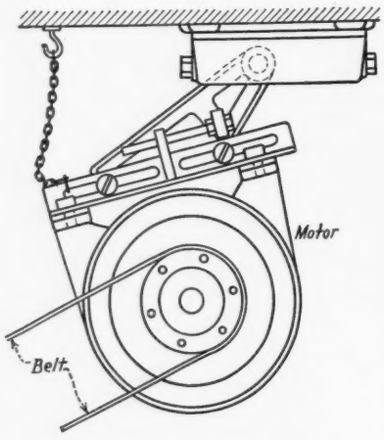
Stability and adequate stress distribution is provided by an adjustable guy rope assembly which runs from the top of the hoist-mounting-post to some point on the transformer tank cover. This makes the transformer tank cover a stress-carrying member and allows the heavy radiator loads to be handled adequately by the light-weight hoist assembly.

An important feature of this hoist is its time-saving over previous radiator-handling methods. Because of its swinging construction only four mounting positions are necessary to service a large power transformer. The time required for setting up in each position is about 15 min. The assembly is so simple in construction and operation that it will serve practically any transformer; thus it answers the requirements of furnishing a standard, simplified procedure for handling all cooling-radiator removal and reassembly jobs.

A saving of one-third to one-half of the time normally required for this type of maintenance work is realized by the use of this hoist assembly. Even more

important in many respects is the greater safety obtainable by its use, especially when the heavier radiators are being handled.

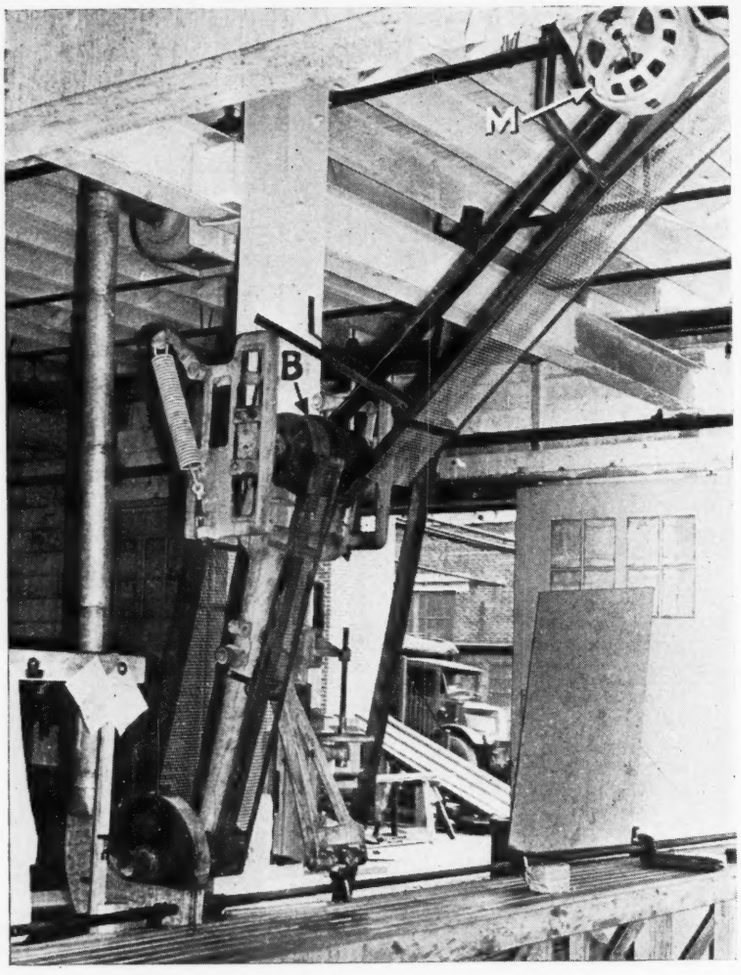
East Pittsburgh, Pa. E M BUITRAGO
Westinghouse Electric & Mfg. Co.



Motor Follows Motion of Countershaft Pulley

RECENTLY in a woodworking plant the engineer had the job of belting a motor to a swinging circular saw. This saw was belt driven from pulley *B* on an overhead countershaft, supported in the saw-swinging mechanism, see photo. Moving the saw across its cut gave the countershaft a certain amount of vertical motion.

The problem was to install the motor so that tension in its belt would remain practically constant as the countershaft pulley moved horizontally. This was done by hanging motor *M* from the ceiling on a tension base as in the diagram so that part of its weight is used to maintain belt tension. When the countershaft changes position the motor swings with it sufficiently to keep constant tension in the belt.



New York, N. Y. L H SKOUGOR
Research Engr,
American Leather Belting Assn

Preventing Corrosion Of Pipe Threads

RUSTING OF PIPING AT THREADED JOINTS can be avoided by using a corrosion-inhibiting compound during installation, or when making repairs. Among the joint pastes are two mixtures that can be easily compounded by the man on the job. The first is made by mixing 1 lb of 200-mesh zinc dust with 1 lb of ordinary linseed-litharge-thread compound and thinning with linseed oil until the batch is reduced to the desired consistency. This compound produces a gas- and air-tight joint and will be found ideal for use on the threads of vacuum-system piping.

To compound a still more-effective mixture, use 2 oz of paraffine, 17 oz of lanolin, 10 oz of powdered sodium-chromate and 30 oz of 200-mesh zinc dust. These ingredients should be warmed together at a temperature of 105 F and blended thoroughly. Should the resulting paste be too thick it can be thinned with naptha until it becomes workable.

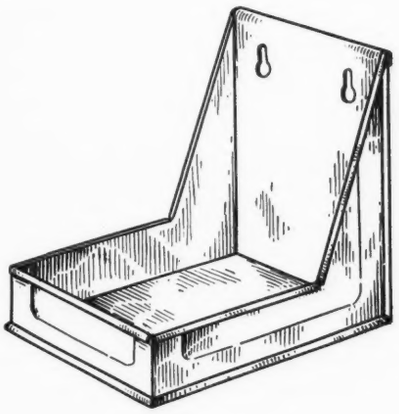
External corrosion of black pipe or of the exposed threaded portion of galvanized pipe can be prevented by painting, using a priming coat containing an inhibiting pigment such as finely ground basic lead-chromate (American vermillion), blue lead (basic lead-sulphate), zinc oxide or metallic zinc. Metallic zinc in the priming coat affords very much the same protection as does galvanizing on iron, by destroying the electrolytic effect almost invariably accompanying corrosion. Iron-oxide paints, however, offer physical protection only; carbon pigments such as graphite, lamp black, oil black, etc, should never be used in the priming coat as they will start electrolytic corrosion.

Painting, if it is to be effective in preventing corrosion, must not only contain inhibiting pigments but must also be properly applied. Surface preparation is all-important. Rust, mill-scale and old paint should be removed by wire brushing or other means. Oil or grease should be cleaned off with a suitable solvent and all traces of moisture eliminated before the paint is applied. Failure to observe these precautions may result in progressive corrosive action beneath the paint film.

Roanoke, Va. S H COLEMAN

Tin Can Makes Small-Parts Tray

BEING IN NEED OF A SMALL-PARTS TRAY for my work bench, I used part of an old square oil can to serve the purpose, see drawing. To add stiffness and give



smooth round edges, the cut edges were first rounded with a file and then turned over. I cut holes in the back of the tray so that it can be hung on two screws in a convenient location in the wall back of the bench.

Penacook, N. H. C H WILLEY

Rules for Successful Air-Compressor Operation

HERE ARE SOME IMPORTANT RULES to observe for successful air-compressor operation:

1. Use as clean and cool air as can be provided by installing air filters on the compressor intake.
2. Use adequate cooling water, as cold and soft as possible.
3. Operate the compressor in the service for which it was designed.
4. Inspect the water jacket, valves, discharge pipe, after cooler, intercoolers, and receiver periodically.
5. Check the temperatures of intake and discharge air regularly.
6. Use a suitable-viscosity, high-quality oil and feed a sparing amount at a uniform rate.
7. Clean cylinders weekly by feeding a soap-water solution of one part soap and 15 parts water for 2 or 3 hours into the cylinder instead of oil. The feed should be about ten times as great as that of oil. After using this solution open all drain-cocks and drain out all soap-water solution. Then feed oil to cylinder for at least ½ hr before closing down the compressor. Do not use kerosene, gasoline, or benzine for cleaning air-compressor cylinders.
8. Use an oil with a low carbon-residue content, within the viscosity requirements.

Blacksburg, Va. JAMES I CLOWER

Boiler-Retubing Job Solved Easily

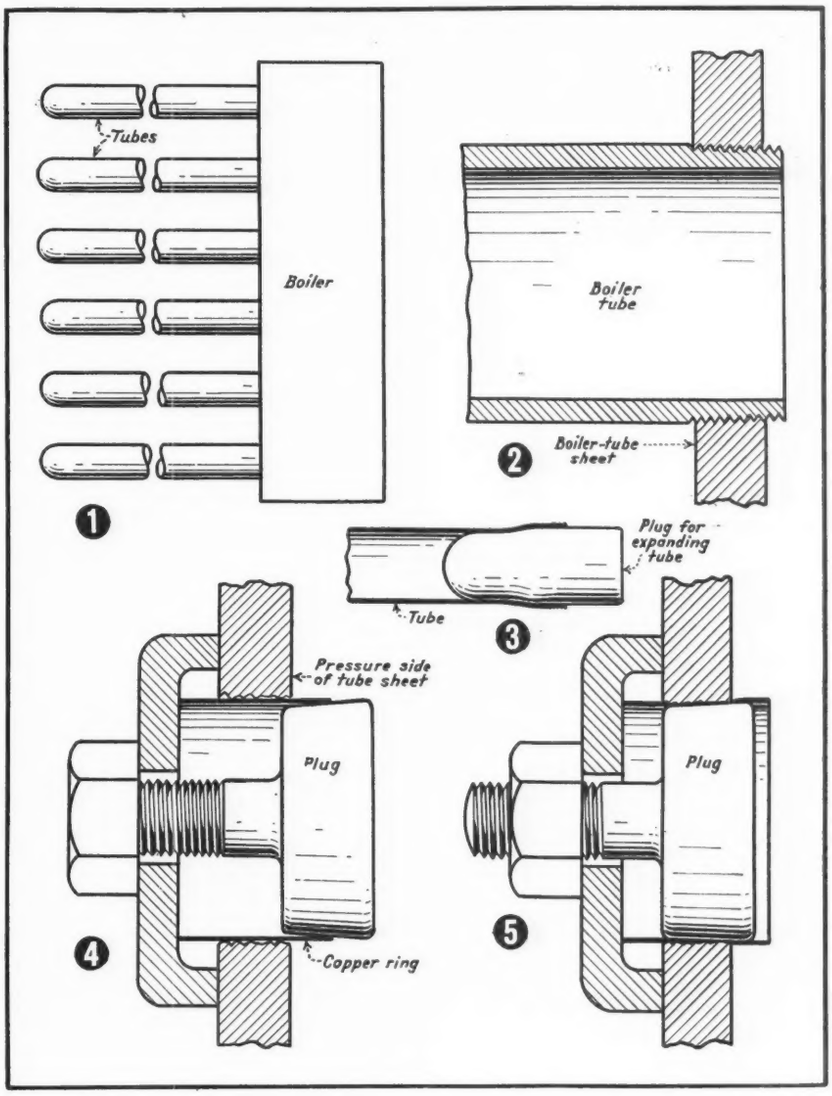
RECENTLY I HAD THE JOB of retubing an old horizontal porcupine boiler. In this type of boiler the tubes are closed at one end and are threaded into the tube sheet at the other, Figs. 1 and 2. When we removed the tubes the threads were found stripped in several of the tube-sheet holes. It would have been quite a difficult job to enlarge the holes and then make them the proper size with threaded bushings, so we expanded the end of the tubes. By running the tap farther into the holes we could cut good threads, with the exception of one hole.

To expand the tubes we heated the threaded ends to a cherry red and drove an expander into them, Fig. 3, to give a slight enlargement. By this process we were able to get a good tight fit of the tubes in the tube sheet.

We plugged the hole into which a tube could not be threaded. To do this we first made a $\frac{1}{16}$-in. thick copper ring that would just fit into the hole and then made a tapered iron plug. The minimum diameter of the plug would just fit inside the copper ring, Fig. 4, and the largest diameter was made slightly larger than the smallest diameter of the hole.

We made a strong-back to tighten the plug against, from a piece of round stock, and machined a recess in it larger than the tube hole, Fig. 4. The plug was tightened into place as in Fig. 5. The first time we tightened the plug into place it leaked. We then removed it and annealed the copper ring, then when the plug was again pulled home it made a perfectly tight joint that remained so in service.

New York, N. Y. S M ELONKA



READERS' PROBLEMS

Questions from Our Readers

Crankpin Loose?

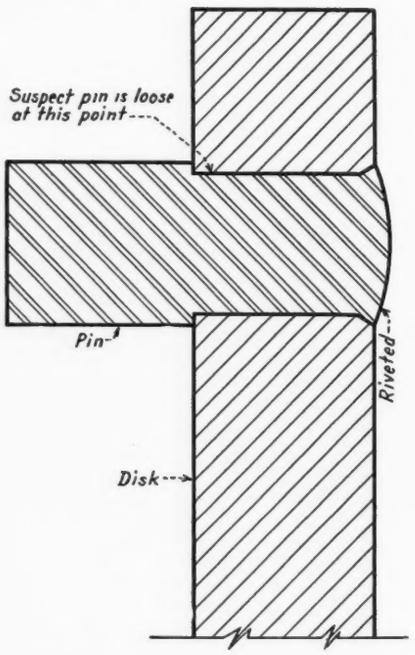
Question 1

WE SUSPECT *that the crankpin on our 28x 42-in., 120-rpm, 825-kva engine-generator is loose. Can some* POWER *reader tell me how to find out if this is the case? The pin has not turned in the disk. The engine is not now in service and steam is not available*—ERG.

How to Synchronize?

Question 2

WE HAVE THREE DIESEL UNITS *generating at 2500 volts, 3 phase, 60 cycle, ac. Each is served by a generator panel mounting load-indicating wattmeter, ac ammeter, dc ammeter, watthour meter, oil circuit breaker, rheostat, dc switch, ac voltmeter receptacle, ac ammeter receptacle, and synchronizing receptacle. We also have one panel for outgoing feeders equipped with an overload protection circuit breaker, watthour meter, and ac ammeter. Our dc panels carry dc ammeters, dc voltmeters, dc switches, rheostats and receptacles. A voltage regulator, synchronism indicator, ac voltmeter, and frequency indicator complete the switchboard.*



We plan to purchase some current from an outside source and would like to know what additional equipment, if any, we need to synchronize our plant with the other source, and how to go about it.—FES.

SUITABLE ANSWERS from readers will be paid for if space is available for publication. Answers accompanied by practical drawings or photographs will command additional pay.

Pump for Cooler

Answers to Jan. Question 1

The Question

IN OUR PLANT, *water, under 15-lb pressure, passes through a double-pipe cooler (2 sections, 12 stands high) and then flows to the sewer through a 2-in. pipe. We want to save this water by pumping it to a water tank 40 ft above. The pumping unit we intend to use on the job is a centrifugal with 2-in. inlet and outlet, driven by a 5-hp motor, at 1720 rpm. The question is: will the pump handle this flow under these conditions, will it hinder in any way flow through the cooler, and what is the best layout for pump and piping?*—JPC

Two Hookups

CONSIDERING THE SUCTION and discharge pipe size, motor hp and rpm of the pump, it sounds like a multi-stage design suitable for higher head than mentioned by JPC. However, the pump described will handle his pumping problem and I therefore suggest the two hookups shown in the sketches.

In the first case, disconnect the water outlet of the condenser at the most convenient point and pipe this line to a second storage tank (of ample capacity, located near the condenser) in which to collect the water discharged by the condenser. Connect the suction of the pump to this storage tank and install a float switch to start and stop the pump motor at the desired levels.

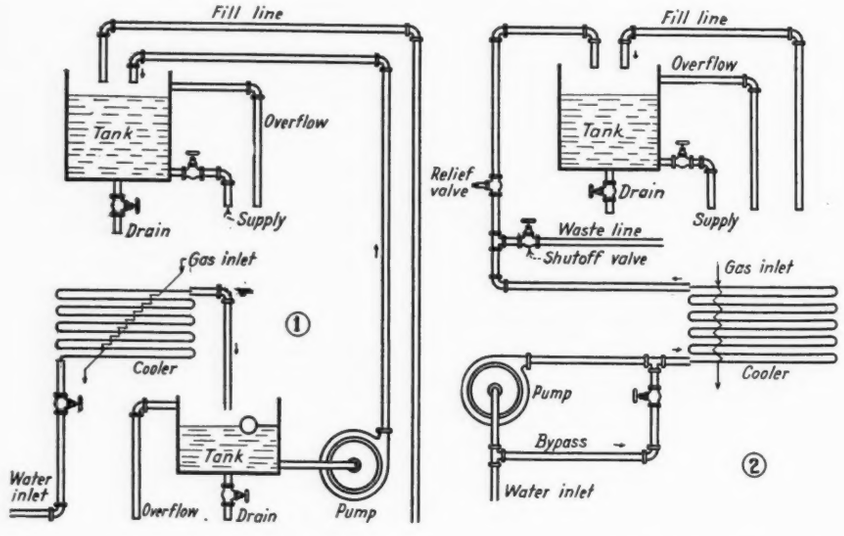
For the second hookup, disconnect the water inlet to the condenser and install the pump in that line, with a bypass. Pipe the condenser discharge to the upper storage tank. This arrangement necessitates constant motor operation as long as the condenser is in operation and complete utilization of the condenser water will be possible only if there are other sources to utilize the water that would accumulate in the upper storage tank and waste through the overflow. JPC does not mention whether power is purchased or generated; neither suggestion considers either economy or efficiency, as JPC seems primarily interested in finding out if an available pump can be used.

New York, N. Y. CARL BACHMANN

Check Exit Temperature

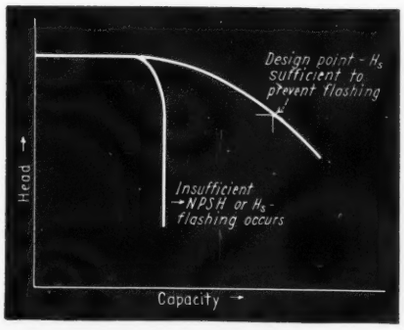
THE INFORMATION GIVEN by JPC is far from complete; no mention is made of capacity, water temperature at cooler exit, or pressure drop through the cooler. Capacity represents no particular problem as a pump can be selected to handle the load at the desired head so that liquid does not back up in the cooler.

However, the exit temperature from the cooler and the pressure drop do represent a definite problem. In any centrifugal pump, a certain suction head is needed to get the liquid into the pump, and when this is accomplished the pump can do its work efficiently. Assume water leaves the cooler at 212 F and the pressure drop is 14 lb, or disregarding any static head above the last coil, the exit pressure is 1 lb g. The net effective head to prevent water flashing into steam before reaching the impeller eye is $H_s + 1.0$ lb. This is



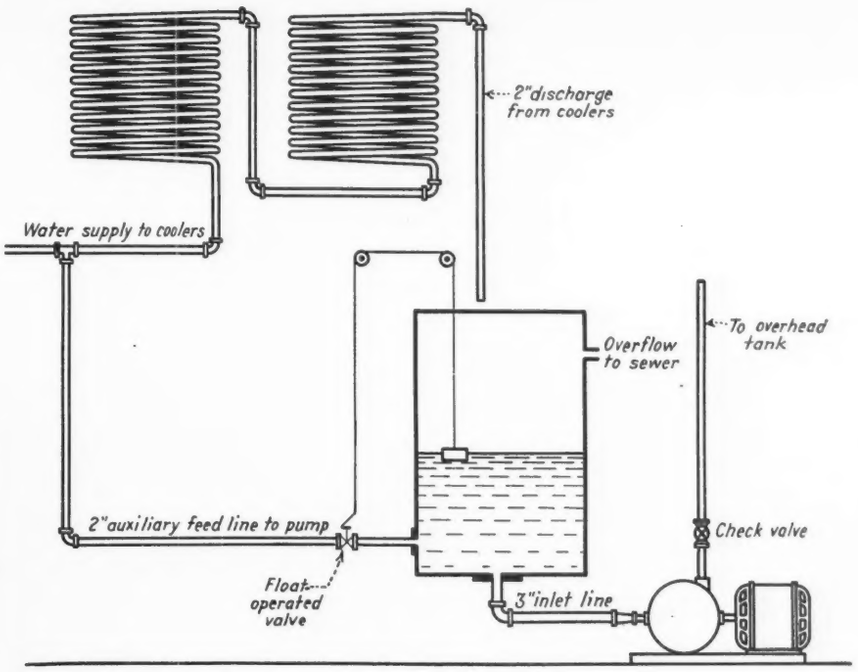
obvious, since the vapor pressure of water at 212 F is 14.7 lb abs so that we have 15.7 lb + H_s − 14.7 = H_s + 1 lb.

Any losses due to a long pipeline or in getting liquid to the pump impeller will cause the slight excess (4 or 5 ft above the vapor pressure) to be used up, the pressure over the liquid will be less than 14.7 lb and flashing will occur. This causes pump capacity to fall off and the liquid will back up into the cooler and retard flow. Cavitation in the impeller eye will occur and this will shorten the life of the impeller. The pump performance curve would be altered as shown.



The pump itself has certain losses which the customer can obtain from the maker. These pump losses result from friction (from suction flange to impeller) velocity head and pickup losses at the impeller eye. On request, the pump manufacturer will supply the NPSH, or net positive suction head above the vapor pressure of the liquid, required for this pump and the customer can then determine what value H_s should have. It is well to note that the vapor pressure of water at 191 F is 22 ft and at 204 F is 28 ft. Other than the question raised above there is no reason why the pump should not handle this flow without hindering operation of the cooler. The sketch shows the best layout; with this scheme the pump is always primed and ready to operate.

Newark, N. J. R C McDONALD



Hookup with Pump Protection

THE SKETCH indicates that the water can be reclaimed by having the present discharge pipe from the coolers discharge into a tank instead of to a sewer. The tank can be a piece of common pipe 6-in. in diameter or over, or could be any steel drum to which a pipe connection could be fastened.

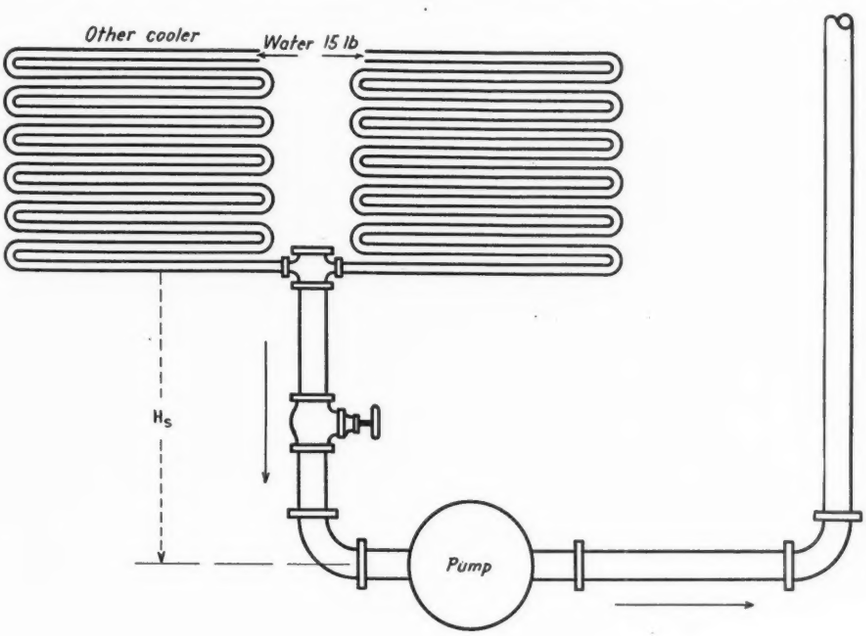
To provide against the pump being damaged from failure of the water supply, an auxiliary feed line to the tank can be installed with a float-operated valve so set that when the level of water in the tank reaches a predetermined low point, the float-operated valve will open and provide water for the pump; or the float mechanism could be attached to the motor starting box so that the pump will start and stop at certain desired levels in the tank.

The inlet line from the tank to the pump should be about 3 in. tapering down to the 2-in. pump connection. With this setup the pump will handle the flow and it will not hinder, in any way, the flow through the coolers.

Pittsburgh, Pa. C J WYROUGH

How to Test Pump

JPC's PROBLEM is typical of many confronting the plant operator; there is a job to be done and far less than adequate data available. As a starting point, let's assume JPC's letter contains all the data at hand. To answer the last part of the question first, I do not see any reason why the pump could not be placed in a closed circuit, either before or after the cooler. There are one or two practical difficulties, however, chief of which is the pump. This would need to be very carefully designed, with proper characteristics; otherwise, it would interfere with cooler operation.



Since the odds are all against the pump on hand being the exact one needed for closed-circuit operation, I would play it safe by installing a suitable sump at the cooler discharge, with an overflow to the sewer, in case the pump should be shut down by accident or intent. With the pump working between the sump and the overhead storage tank, it could not possibly have any effect on cooler operation.

The next matter to consider is the quantity of water to be pumped. This can be checked with sufficient accuracy by temporarily discharging the cooler into a tank of known volume—such as a 5-gal bucket or an oil barrel—and measuring the time needed to fill it, using a watch, or better, a stopwatch. Do this several times and take the average. Knowing the

quantity of water to be handled, we are now ready to check on the pump.

Make a temporary pump setup, using an oil barrel or other convenient tank as a sump suction. Pipe up the discharge with a globe valve and a swinging joint so the pipe outlet can be swung over either the barrel or the measuring container. Provide an ordinary 50-to-75-lb-range pressure gage known to be accurate. Install this on the pump side of the discharge valve as shown in the sketch. Fill the sump with water, prime the pump, and start the latter with the discharge valve closed. Then slowly open the valve, discharging back into the sump, and adjust the valve until the gage reads the pressure equivalent to the static discharge head (40 ft = 17.32 lb per sq in.).

When all is in readiness, and with watch in hand, swing the discharge pipe from the sump to the measuring vessel and check the time needed to fill it. Do this several times, taking the average, which will be the quantity of water the pump will discharge under actual conditions except for the error due to the friction head. Using this quantity, calculate the friction discharge head for the expected pipe layout.

Then start the pump again, adjusting the discharge pressure to include the just calculated friction head, and make another series of measurements. Results of this second run will more closely approximate results to be had with the actual installation than did the first run. The operator will have to use his judgment to determine when the error in results is so small as to be negligible. Bear in mind that extreme accuracy is not possible since the method of flow measurement is not particularly precise.

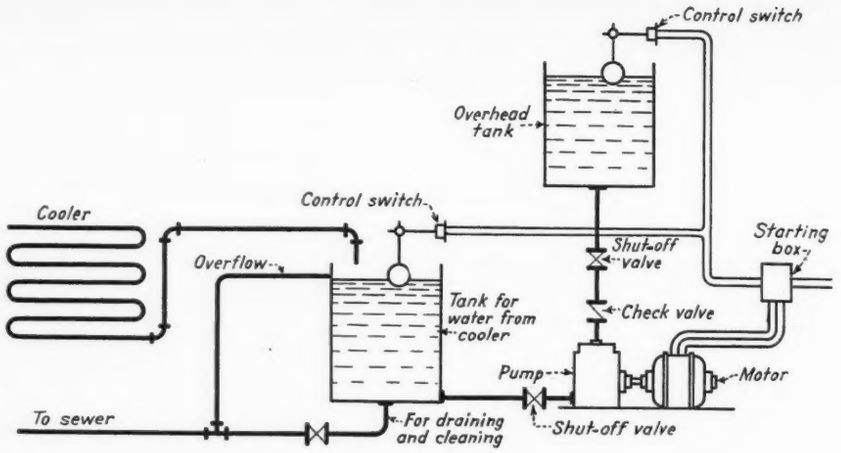
Now compare pump capacity with the measured rate of flow through the cooler. If the former is greater, you are lucky; if the latter, swap off the pump for a larger one. Assuming that the pump has sufficient capacity it would be best to check the motor load. For this, use the following:

$$\frac{\text{Gpm} \times 8.33 \text{ lb per gal} \times (\text{static head in ft plus friction hd, ft})}{33{,}000 \times 70\% \text{ pump efficiency}}$$

which gives horsepower required. The efficiency is placed at a low point as it would be well to err on the safe side with an unknown pump. If the horsepower thus determined greatly exceeds the motor nameplate rating it would be well to make another test of the motor-pump assembly and check the current input to the motor to be sure it is not overloaded.

If both pump and motor prove to be adequate, proceed to make the installation, as indicated in the sketch. The simplest job would have a hand-operated globe valve or throttling valve on the discharge side by which to control the pumping rate close to the rate of flow through the cooler. A somewhat more elaborate arrangement would have a float-operated balanced valve in place of the globe. The pump may be placed either above or below the cooler discharge sump according to the dictates of the plant arrangement. The latter position is to be preferred as it eliminates the necessity for a foot valve and makes the pump self priming.

Tecumseh, Kansas H M NAYLOR

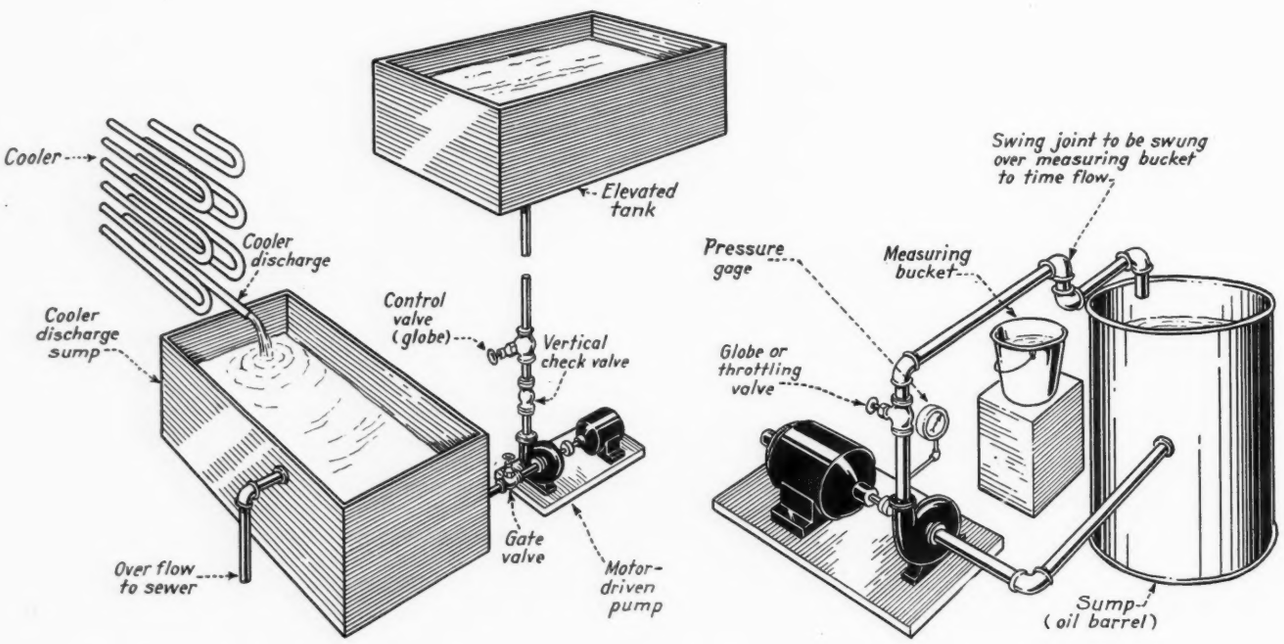


Two-Switch Control

JPC's BEST BET is in installing a tank for the flow from the cooler, water from this tank being pumped to the overhead tank. The pump can be controlled by switches in both tanks. The switch in the upper tank should be set to operate at a higher level than the regular control. Then, as long as enough water was coming through the cooler to supply the needs, the regular supply would be shut off. With controls in both tanks, the pump would only run when water was needed in the upper tank or when there was water in the lower tank.

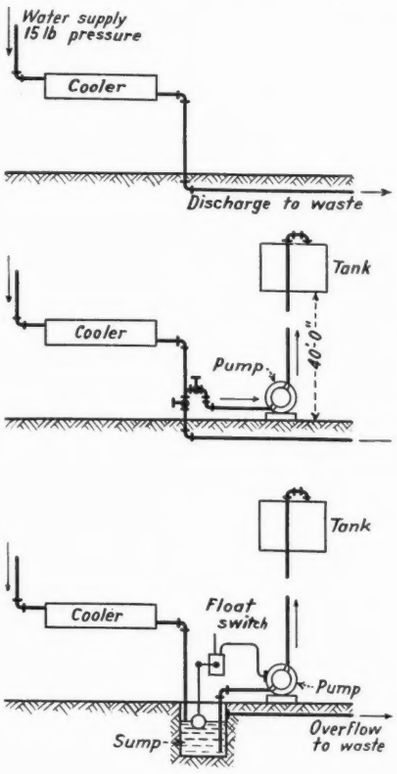
As the capacity of a centrifugal pump depends more on the impeller design than the pump size, JPC should contact the manufacturer to find out capacity and power requirements. If designed for a 40-ft head it should operate satisfactorily.

Lombard, Ill. H D BROWN



Get Data from Maker

THE INFORMATION GIVEN, especially as to pump characteristics, is not enough to make possible a definite answer, but presumably the present arrangement is as shown below. The hookup JPC is considering is



shown in the middle. If the pump will handle the flow at the same rate as at present, it should not, in any way, affect cooler operation. However, whether the pump can do this, and at the same time, deliver water to a tank 40 ft above ground, can only be decided after characteristics of the pump have been ascertained.

No doubt JPC knows who made the pump and if he will give the manufacturer the data contained in his inquiry, together with the rate at which water is to be discharged from the cooler, in gpm, they will no doubt be able to tell him whether the pump can be used for the desired purpose and the conditions under which it will operate. Apparently the equivalent head will be about 50 or 60 ft, but there will be a head on the pump suction of 15 lb, less the friction loss through the cooler, piping, etc, so if the pump manufacturer is given the rate of flow he will have most of the data necessary.

It appears reasonable to assume that flow through the cooler is controlled by a valve, which introduces an artificial loss of part of the 15-lb head and it would help if JPC also told the maker the rate of flow when the valve is wide open and the length and size of the discharge pipe from the cooler.

If the pump will not operate satisfactorily as above, it can be used as shown in the bottom diagram of the three above. In this case, flow through the cooler

(Continued on page 168)

Smoke Troubles

Answers to Jan. Question 2

The Question

WE HAVE ONE 516-hp Erie boiler with a 5-retort Taylor stoker and two 250-hp McNaulls, with old-style shaft-driven Taylor stokers. One of these latter had an air back installed recently. The draft system includes a 150-ft stack and forced-draft fan. We burn all classes of coal supplied by the railroad system serving our plant. On the two small boilers we have trouble with occasional spells of smoking, that is, they will smoke for several hours at a time and then stop. This will happen on the same car of coal and under the same conditions. We keep retorts free of clinker, adjust thickness of fires to size of coal. Stack draft is good, tubes are deslagged and gas passages clean. We can reduce draft but the smoking still occurs. My only solution is that our bricklayer keeps building out the sidewalls in making brickwork repairs. Can any POWER *readers suggest reasons for this smoke difficulty?*—LT

The Real Answer

AS LT'S QUESTION referred to a Taylor stoker, we identified the plant and investigated the matter in the field. We found that the smoke reported was issuing from the coal hopper and not from the stack. It occurred only in the case of two 3-retort stokers of the design popular in 1913 and was caused by uneven distribution of the coarse and fine coal.

Operators of underfeed stokers quite generally are aware of the fact that the even distribution of coarse and fine coal across the width of the hopper not only produces better combustion results, but eliminates smoking of the type under consideration. Cases of this kind sometimes occur where air leaks in the front-wall construction were produced by using ill-fitting repair parts not obtained from the stoker manufacturer.

Philadelphia, Pa. C W BALDWIN
Stoker Div, American Engineering Co

Blames Breeching

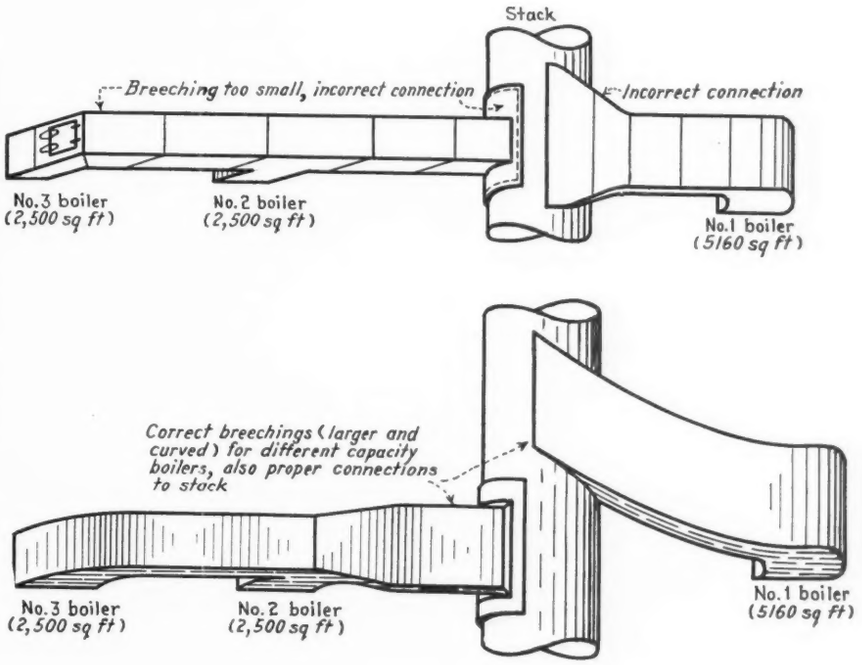
IT LOOKS FROM THE LIMITED DESCRIPTION of LT's plant that the 5160-sq-ft water-tube boiler replaced either one or two 2500-sq-ft boilers, making the present plant one 5160- and two 2500-sq-ft units. In all probability the same stack that served the previous boilers serves the present ones, with a probable lengthening to 150 ft.

The fact that the large boiler operates satisfactorily under load conditions without excessive smoking, shows that the uptake or breeching of this boiler must be of correct dimensions to cope with the volume of furnace gas passing to the stack. It is natural to assume that volume of gas from the large boiler will be greater than the combined volume from the two smaller boilers, consequently the larger volume of gas could offset the draft efficiencies of the two smaller boilers, under equal draft conditions.

The breechings of the two smaller boilers may be too small for their length, causing a cooling effect on the gas, reducing the draft and causing smoke. The settings may be low, that is, the clearance from retorts to the lowest bank of tubes may be inadequate. This condition would restrict combustion and combined with a small (narrow or shallow) combustion chamber, would result in smoking. Before considering resetting the older boilers to give larger furnace volume, and correctly designed breechings, weigh the cost against completely new boilers.

Grand Rapids, Mich. J M GORRIE

More answers on page 170


Stack
Breeching too small, incorrect connection
Incorrect connection
No.3 boiler (2,500 sq ft)
No.2 boiler (2,500 sq ft)
No.1 boiler (5160 sq ft)
Correct breechings (larger and curved) for different capacity boilers, also proper connections to stack
No.3 boiler (2,500 sq ft)
No.2 boiler (2,500 sq ft)
No.1 boiler (5160 sq ft)

Figuring Orifices

By PHIL SWAIN

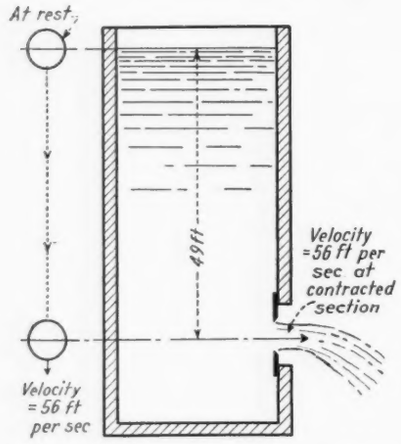


Fig. 1—Velocity of jet at contracted section equals that of body falling (from rest) from water-surface level to level of orifice center

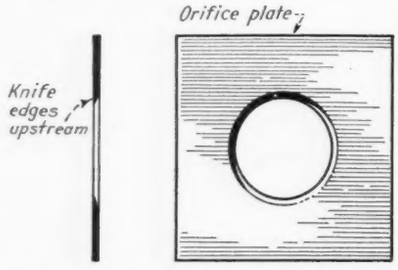


Fig. 2—Bevel orifice in metal plate to a sharp knife edge, with flat side *upstream*

FIGURING PRESSURES of gas (page 115, January POWER) or water (page 113, February) is easy as long as the fluid is at rest. When it starts to move, things get a little more complicated, yet some of the important rules for water in motion are simple.

First let's consider orifices, widely used to measure the flow of water and other fluids. The metal-plate orifice (Figs. 1 and 2) is bevelled to a sharp knife edge with the flat on the *upstream* side.

With an orifice of this type the jet *area* will always contract about 40% after leaving the orifice. The velocity of the water at the contracted section (called the *vena contracta*) will be practically the same as that of a body falling freely from rest a vertical distance equal to the head of water on the orifice. The formula is:

Velocity = 8 × square root of head

In this formula the head is measured in feet and the velocity comes out in feet per second. The head shown in Fig. 1 is 49 ft. Since the square root of 49 is 7, the velocity will be 8 × 7 = 56 ft per sec. If the contracted section in this case is 0.01 sq ft, the flow will be 56 × 0.01 = 0.56 cu ft per sec.

It is customary to use the full area of the orifice and then multiply the flow thus figured by a correction factor or "coefficient" to allow for the contraction and also for the slight loss of water velocity. For the sharp-edged orifice shown, mounted in a box or pipe much larger than the orifice, the coefficient may be taken as 0.60. Then the flow formula will be:

Flow = 8 × square root of head × orifice area × 0.60. Head must be in feet, orifice area in square feet. Flow will come out in cubic feet per second.

Example: How much water will a pressure of 100 lb per sq in force through a 1-in., round, sharp-edged orifice?

Solution:

Area of 1-in. circle = 0.785 sq in = 0.00545 sq ft

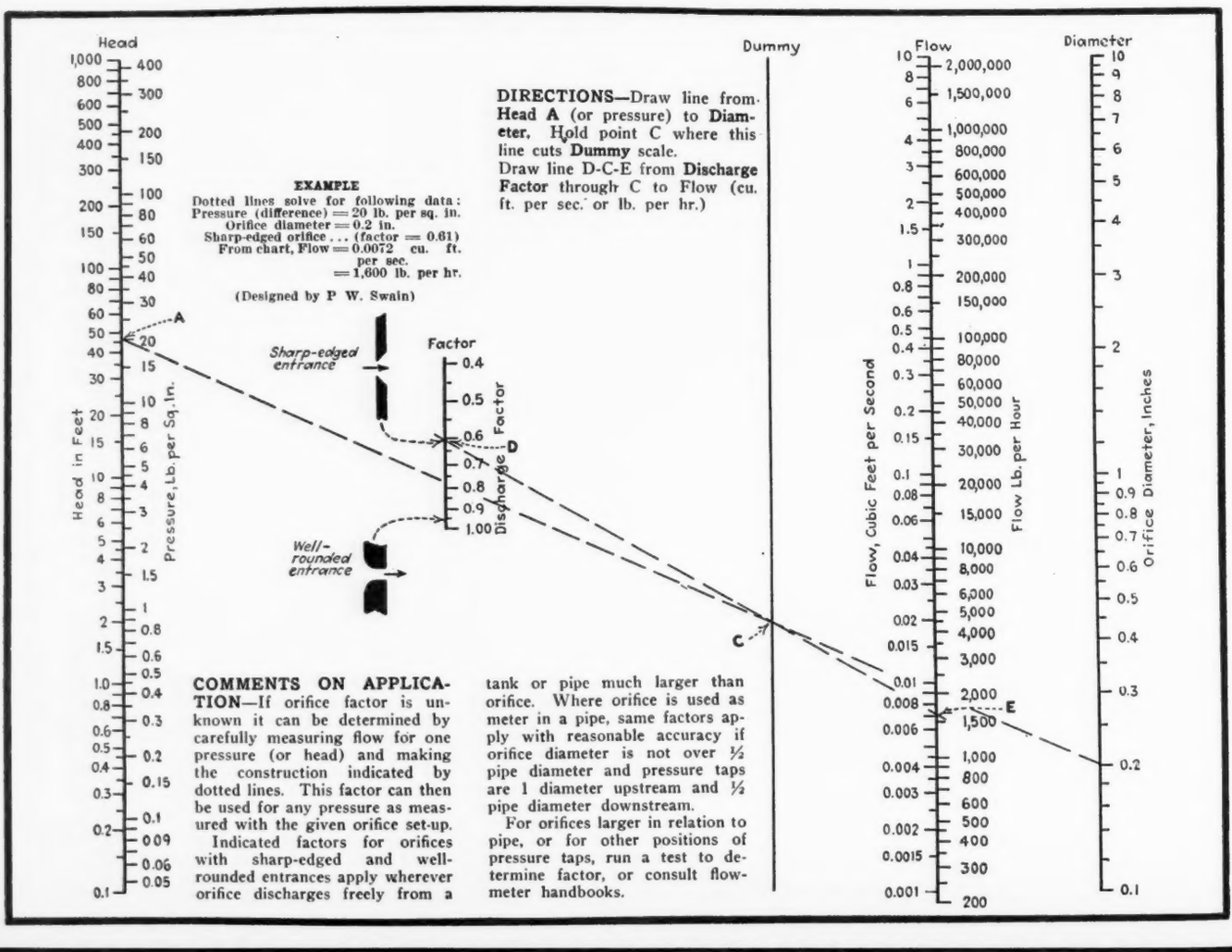
Head = 100 × 2.3 = 230 ft

Square root of head = 15.2

Flow = 8 × 15.2 × 0.00545 × 0.6 = 0.40 cu ft per sec

Such problems may be solved more easily with the chart shown in Fig. 3.

Fig. 3—Flow of water through orifices (from POWER Data Sheet No. 51)


Head
Head in Feet
Pressure, Lb. per Sq. In.
Dummy
Factor
Discharge Factor
Sharp-edged entrance
Well-rounded entrance
Flow
Flow, Cubic Feet per Second
Flow Lb. per Hour
Diameter
Orifice Diameter, Inches
A
C
D
E
EXAMPLE
Dotted lines solve for following data:
Pressure (difference) = 20 lb. per sq. in.
Orifice diameter = 0.2 in.
Sharp-edged orifice . . . (factor = 0.61)
From chart, Flow = 0.0072 cu. ft. per sec.
= 1,600 lb. per hr.
(Designed by P W. Swain)
DIRECTIONS—Draw line from Head A (or pressure) to Diameter. Hold point C where this line cuts Dummy scale.
Draw line D-C-E from Discharge Factor through C to Flow (cu. ft. per sec. or lb. per hr.)
COMMENTS ON APPLICATION—If orifice factor is unknown it can be determined by carefully measuring flow for one pressure (or head) and making the construction indicated by dotted lines. This factor can then be used for any pressure as measured with the given orifice set-up.
Indicated factors for orifices with sharp-edged and well-rounded entrances apply wherever orifice discharges freely from a tank or pipe much larger than orifice. Where orifice is used as meter in a pipe, same factors apply with reasonable accuracy if orifice diameter is not over ½ pipe diameter and pressure taps are 1 diameter upstream and ½ pipe diameter downstream.
For orifices larger in relation to pipe, or for other positions of pressure taps, run a test to determine factor, or consult flowmeter handbooks.

ARGUMENT CORNER

Do You Ken John McFadden?

JOHN MCFADDEN was born in Scotland in 1906. At one time he was assistant engineer at the Hotel Martinique, New York City. Metropolitan Life Insurance asks POWER's help in finding this man. His policy has matured and they want to give him a check.

If you know or knew Mr McFadden please send your information or clews to the editor of POWER or direct to John B Northrop, Manager of Claim Division, Metropolitan Life Insurance Company, New York, N. Y.

A Lesson in Geometry

DOES POWER'S EDITORIAL STAFF really remember so little of their geometry that they accepted Mr Spring's construction (January, page 107) as being accurate, or were you just trying to see how many letters you would receive advising that his method would not give the true center of the circle?

The perpendicular bisector of any chord must pass through the center of the circle so that, if two chords are taken, the intersection of the two perpendicular bisectors will give the true center of the circle. Thus, if Mr Spring had connected the intersections of arcs *E* and *F*, *G* and *H* for one line and the intersections of arcs *I* and *J*, *K* and *L* for the other line, he would have had a true center; whereas his method is only as accurate as the diameter *AB* and the accuracy of the right angles between the diameters *AB* and *CD*.

Of course, not knowing the center of the circle, *AB* could not be very accurate as a true diameter, and, if the line *CD* is constructed at right angles to *AB*, it may still not be a diameter.

Jackson Heights, N. Y. J C GLENN

[UP TO TIME OF GOING TO PRESS *Mr Glenn's is the only comment we have received on this "inaccuracy." From the strictly geometrical angle, Mr Glenn is right in that Mr Spring's method introduces an error if the chosen centers for the arcs do not lie exactly on two perpendicular diameters of the circle. Actually the error is negligible for most practical work, if the centers are roughly squared by eye.*

The situation is like that of measuring the width of a board. Theoretically the scale should be set on a cross line drawn with a square, but this is rarely necessary because a 1 degree skew of the scale produces only 1/50% error.

To settle this argument in a practical way, we suggest that some of our readers try Spring's method several times and report the actual error.—Ed.]

How to Become An Expert

WHEN I WAS in my 'teens and early twenties, hence knew a great deal more and was surer of it, than now "in the sere and yellow leaf", I was a fire-engine "buff"—that being the expression of the period, corresponding to our present-day "fan". And whenever occasion presented, I used to wend my steps to my favorite engine-house, which accommodated an Amoskeag machine, then the most popular type.

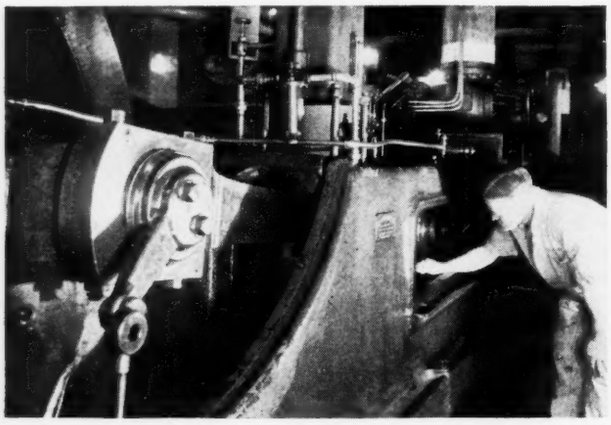
From asking questions and watching dismounting and adjustments, I got to being asked for advice—the idea being that any one working hard at becoming an engineer, and, anyhow, any one having as smart a brother as I had, must be worth listening to. Eventually I

(*Continued on page 146*)

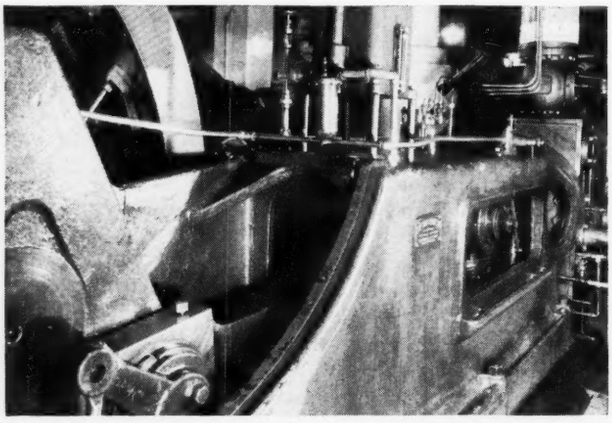
"Tsk, Tsk, Orville—Imagine, no limit switch!"

HOW TO SET AN ENGINE ON DEAD CENTER

▶ ACCURATE VALVE adjustment requires finding exact *dead center*, that is, the point where the piston is at the extreme end of its stroke. A small error in crankshaft position will make a big difference in valve position. Accuracy depends on measurements at the flywheel, which moves through proportionately greater distances than the crosshead or piston, so that slight inaccuracies in measuring do not seriously affect the result.



1 Place the engine in the position shown, with the crosshead somewhere near the end of its stroke. Scribe a line on crosshead and guide to mark this position. Leave the engine in the same position until a suitable mark has been made on the flywheel



3 Bar over the engine until the crosshead and guide marks are again in line, but with the crank in the opposite position. Scribe a mark on the flywheel as before. These flywheel marks represent exactly opposite crank positions; dead center is halfway between

2 Mark the flywheel with some form of tram set in a center-punch mark or other fixed point on floor or engine frame. The tram can be made of steel wire, as shown, or a wooden stick or ruler may be used. In many cases it may be more convenient to set up a fixed marker fastened to the engine frame

Pictures taken by POWER *at Beth Israel Hospital, New York, through the courtesy of Frank Smart, chief engineer, and with the direct assistance of John Walker, ass't chief engineer, who handles the tram and dividers.*

4 Using dividers, a steel tape, or other suitable measuring method, locate a point exactly midway between the two marks scribed on the flywheel with the tram

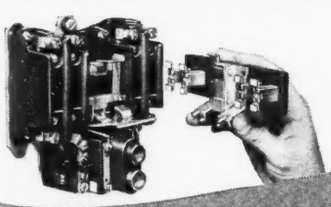
5 Bringing the center mark into line with the tram point puts the engine on exact dead center, in this case, on *head-end* dead center. *Crank-end* dead center can be found by repeating this process or by measuring halfway around the flywheel circumference to find the diametrically opposite point

Doesn't It Beat All How DIRTY *Things Get!*

THE annual spring cleaning which is a bane in every housewife's life, is mute testimony to a fact of far-reaching significance to factory executives and maintenance men. *Dust is everywhere, gets in everywhere, and settles on horizontal surfaces.*

Dust is a destroyer where Motor Control is concerned. Dirty contacts mean trouble. Horizontal contacts collect dust. Vertical contacts stay clean. So, experienced and profit-minded factory men insist on Cutler-Hammer Motor Control . . . the control with dust-safe Vertical contacts. You too insist on Cutler-Hammer, and see the difference. CUTLER-HAMMER, Inc., *Pioneer Electrical Manufacturers,* 1358 St. Paul Avenue, Milwaukee, Wis.

Cutler-Hammer *Vertical* Contacts are the mark of *better* Motor Control, another extra dividend on Cutler-Hammer's unequalled specialized experience and decades of Motor Control leadership.



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Dust Safe VERTICAL *Contacts*

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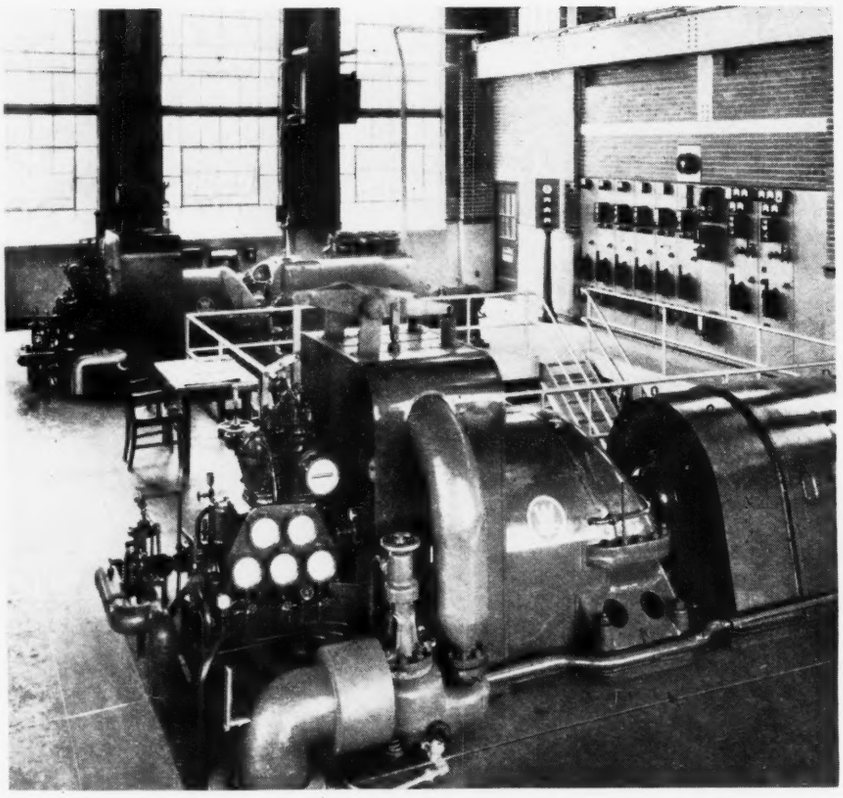
Experience Report on Turbine-Governing Problems

American Institute of Electrical Engineers analyzes steam- and hydraulic-turbine-governing problems from the results of a questionnaire sent to power companies



Steam-turbine generators, because of the smaller time lag associated with governing steam flow compared to water, are inherently capable of producing greater stabilizing influence on system frequency than are hydraulic-turbine generators

▶ DURING THE LAST TWO OR THREE YEARS an increasing amount of attention has been focused on load swings, turbine-generator (both steam and hydraulic) governing, and stability of power systems when both operating alone and interconnected. The importance of these problems was further emphasized by the Power-Generation Committee at the winter convention of the American Institute of Electrical Engineers, held in Philadelphia, Pa., January 27-31. The committee devoted an all-day session to these subjects, at which seven papers were presented and discussed.

A sub-committee of the Power-Generation Committee was assigned the task of crystalizing governing problems and outlining the desirable functional characteristics of a governing system. In dealing with the first part of this assignment the sub-committee submitted to 20 operating companies a questionnaire to obtain a cross-section of opinion as revealed by present operating practices.

Three Kinds of Questions

The questions were divided into three groups. One group defined the operating requirements in so far as they are affected by the size of the system, proportion of steam and hydro, type of present governors, roughness of load, interconnection, etc. A second group told how these requirements are currently being met by showing the amount of droop used and the procedure in regulated frequency and tie-line loads. A third group concerned tests made on governors. It was felt that the amount of governor testing would furnish a good index of how serious the governor problem has been in the past.

There has been some evidence that ordinary measuring devices, such as graphic frequency meters, tachometers, etc, are not fully adequate for checking governor performance, and a question was included to obtain opinions on improved instruments for this purpose. Another question was asked to bring out opinions on the adequacy of present governors and any forward thinking as to the lines along which improvement should be directed.

An analysis of the answers to these questions was presented in a paper "Power-System Governing—The Problem," by J J Dougherty, A P Hayward, A C Monteith and S B Griscom. A study of the answers did not reveal a well-crystallized statement of the governor-control problem. A surprisingly large number reported satisfaction with present governing equipment. Most companies reporting present governors essentially satisfactory have fairly steady loads or have made few tests of governor performance. Companies reporting particular interest in governors are those which serve heavy industrial and electrified railway loads.

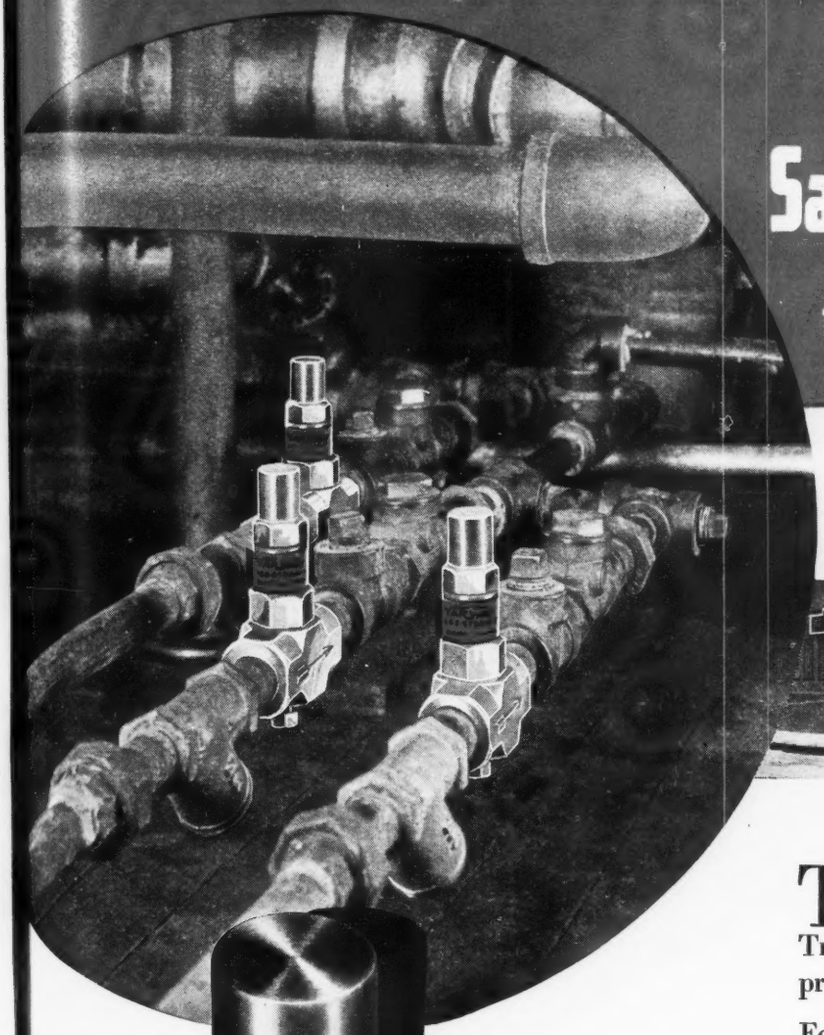
Some difficulties arise from operating the newer high-speed turbine generators, equipped with fast governors in parallel with older units having slow governors. Equipment is available for some types of these fast governors to increase their regulation under transient conditions, thereby providing a means of sharing the load swings without interfering with the speed regulation for steady-state conditions.

Another application trouble results

(*Continued on page 118*)

Individual Trapping with YARWAYS Speeds Heating-up Saves Shut-Down Time

for Eagle Dye Works, Hartford, Conn.



TWO YEARS AGO, the Eagle Dye Works of Hartford, Conn., installed several Yarway Impulse Traps . . . liked them so well they trapped all their presses with Yarways.

Formerly they had used one large trap of another design to drain each group of from four to six presses. This resulted in sluggish heating-up and whenever anything happened to one trap, a battery of machines had to be shut down until the trap could be repaired.

Individual trapping of all twenty-four presses with Yarway Impulse Traps has increased heating efficiency, reduced down-time of presses, practically eliminated trap maintenance trouble and expense.

Let the Yarway Trap show you what it can do to end your trap troubles, give you quicker heating and greater sustained heating efficiency, save you money on installation, maintenance, fuel—and you, too, will standardize on the Yarway.

See your Mill Supply dealer or write for Catalog T-1735.

YARNALL-WARING COMPANY
100 Mermaid Avenue Philadelphia

YARWAY IMPULSE STEAM TRAP

Experience Report on Turbine Governing

(Continued from page 116)

from the oil-supply pressure for the operating cylinders not being sufficient to provide the required force to move the inlet valves in step with the governor. This, however, can be corrected by adding oil accumulators. Many of the units require the governor to furnish the actuating force for the rocker arms and links between the governor and the inlet valves. The force required to move these masses rapidly may not be available from the governor for load swings or overspeed. Here it is necessary to add an intermediate relay and operating cylinder to translate the motion of the governor.

Operating difficulties to which governors are subjected are considered to be these troubles that can be remedied by proper maintenance and adjustment. It has been found that the majority of governor troubles fall into these classifications. In many cases, the blame cannot be placed directly on the governor, because after overhaul periods or other work which has required the tearing down and assembling of the governor, no test procedure has been set up to determine if the governor operates satisfactorily. Operation of the governors is usually observed for a period after overhaul, but this type of check is mainly of value in detecting hunting.

Governor Hunting

Governor instability or hunting is a difficulty that is most commonly observed. Hunting may be due to several factors, such as an extremely fast governor, very sluggish governor, or improper adjustment of the control mechanism. There may also be indications of hunting when fast governors are operating in parallel with slow governors. An analysis of several of these cases has shown that what appeared to be hunting was nothing other than the fast governors accurately following the speed changes by regulating more than their share of the load until such times as the slow machines became active.

Some apparent cases of governor hunting are caused by excessive variations in steam pressure which directly affect the output of the turbine generators. Another example of generator load swings erroneously identified with governor hunting are those caused by electromechanical oscillations between the various generating units, usually induced by load shifts on the transmission system.

Governing of hydroelectric units means relatively slow gate movement because of conditions that can develop because of the physical characteristics of the water

Adjustment of the control mechanism can cause hunting by having the speed of response too fast for the inertia characteristics of the generating unit or by over-compensating a sluggish governor. Another trouble that is frequently found, but can be determined usually only by special tests, is an erratic speed droop. Very few steam turbines have a uniform load response for a given speed variation over the entire load range. This is due to fundamental characteristics of the governor operated by centrifugal force, variation in the angularity of the links and rocker arms, and the output characteristics of the inlet valves.

Some types of governors are very sensitive to variations in forces existing on the inlet valves at various openings. On multivalve turbines, the incremental speed regulation usually varies considerably just preceding and after the opening of an inlet valve. In some cases, valve overlaps, which have been determined for purposes of economy, have been reduced to such a degree that dead spots exist in the governor. Another cause of excessive speed droop, which cannot be overlooked, is the change in steam pressure with change in load.

Speed droop is usually determined for steady-state conditions. However, actual speed droop will change with the rate of load change. It is not unusual to find a governor which shows an over-all speed regulation of 4% actually operating at a speed droop of 10 to 20%, for load swings such as those produced by a steel mill.

Another major trouble is lack of sensitivity of the governing system either to speed changes or to load adjustments by means of the speed changers. This difficulty is usually the result of excessive friction. A governor with excessive friction may operate satisfactorily when the speed is steady, being erratic in operation only when adjusted by means of the speed changer. This same governor, under a less steady system speed, may creep.

Investigations of governor performance have shown that many of their troubles can be laid to inadequate maintenance. On the other hand, there is evidence that something less than perfect governor performance may still be satisfactory where the steadiness of the load does not demand exceptionally close governing. Tests have shown that many governors which appeared to be satisfactory were not functioning properly. The main difficulties were found to be excessive friction, improper adjustment of intermediate relays, and improper setting of valve cams and compensators.

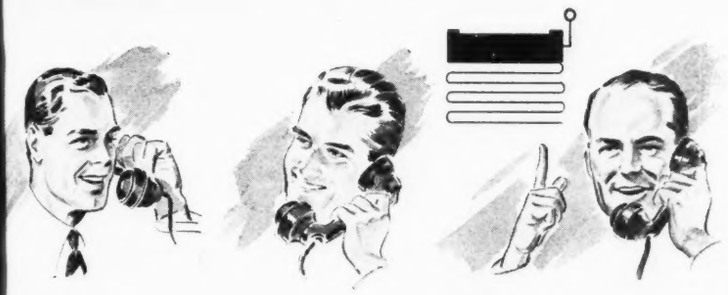
(*Continued on page 142*)

How to Save $15,000

A REMARKABLE CASE SHOWING SCOVILL'S "3-WAY" CONDENSER TUBE SERVICE IN ACTION

For buyers of Scovill Heat Exchanger Tubes, the actual purchase of the tube is only a part of the story. In close touch with the problems of tube users, Scovill offers them its 3-way service—in men, metals and manuals—designed to reduce the costs and save the time of the engineer. Pictures on this page show Scovill's 3 services in action.

METALS Admiralty alloy has for years been widely used for condenser, heat exchanger and heater service. It usually served well and economically, but in certain conditions failed from dezincification. Scovill engineers worked intimately with this problem — developed "Phosphorized Admiralty,"* a new alloy which has all the good qualities of Admiralty but which will not fail from dezincification. And thousands of dollars thereby will be saved by operating companies in Power, Refinery and Marine Plants.



MEN A power plant engineer, because of enlarged tube sheet holes, was experiencing chronic leaks at the ferrule and packing joints of his condenser. He pondered replacement of the $15,000 tube sheets but before doing so called a Scovill technical service man. Scovill suggested as an alternative a change in installation method which would eliminate the difficulties due to the enlarged tube sheet holes and eliminate the ferrule and packing as well. This change was made — saving $15,000.

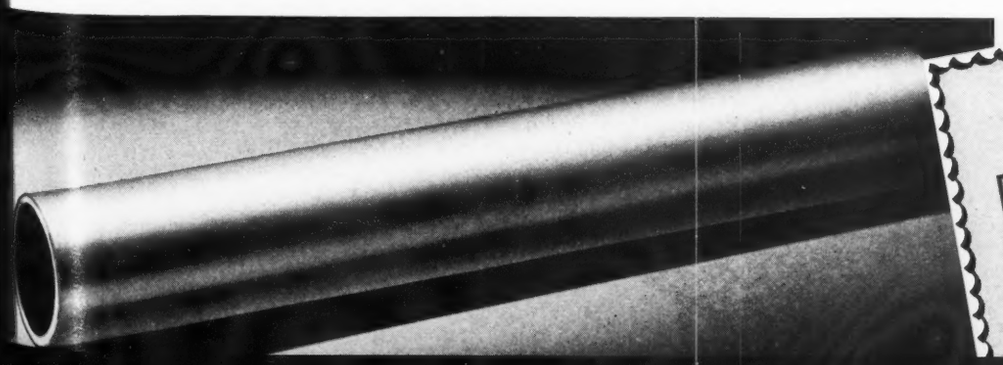
MANUALS And reflected in Scovill's new "Condenser Tubes" booklet is this constant development.

SCOVILL CONDENSER TUBES
one product . . . three services

- **SERVICE IN MEN**
- **SERVICE IN METALS**
- **SERVICE IN MANUALS**

This "Condenser Tubes" booklet has money-saving facts for you, and will be sent on request. Address Scovill Manufacturing Co., 13 Mill Street, Waterbury, Connecticut.

*"Phosphorized Admiralty" tubes are covered by Patent Number 2,224,095.



Scovill
MANUFACTURING COMPANY
WATERBURY, CONN.

POWER LINES

Engineers Discuss Fluorescent Lighting

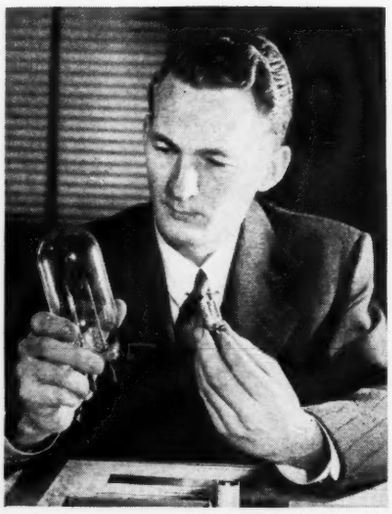
A general discussion on the forward strides made by fluorescent lighting, followed by a detailed explanation of the operation of the glow-switch lamp starter, were the features of a technical session on fluorescent lighting, held as part of the Midwinter Convention of the American Institute of Electrical Engineers, in Philadelphia, Pa., Jan 29. The session, and the conference which followed, was sponsored by the Committee on Production and Application of Light, jointly with the Philadelphia section of the Illuminating Engineering Society.

"Fluorescent Lighting Fills a Gap," paper presented by A A Brainerd, Philadelphia Electric Co, covered the period immediately following the introduction of the new lamps, April 21, 1938, up to date, with present practice in the application of the lamps. He pointed out, that though fluorescent lights were being used more and more extensively, they were not the solution to all lighting problems. In several instances he showed examples where the size and bulk of the fluorescent lamp and auxiliaries were a distinct disadvantage in the solution of a lighting problem, and proceeded to illustrate, with slides and cardboard examples, how the problem could be solved easier with incandescent or mercury lamps. His paper did bring out, however, the many and varied uses to which the lamps could be and are put advantageously.

R F Hays, Westinghouse Electric & Mfg Co, delivered a detailed explanation of the glow-switch, used to start fluorescent lamps. Slides showing a fluorescent lamp circuit, breakdown voltage with respect to gas pressure and electrode separation, and assembly of the glow-switch were included as part of the talk.

The conference on lighting problems brought out the fact that lighting equipment has been further developed than lamps. This includes, starters, ballast equipment, etc, as described by A B O'Day, General Electric Co, Cleveland.

Oscar P Cleaver, Westinghouse Electric, brought out various percentage comparisons with the fluorescent lamp



R F Hays, Westinghouse Electric & Mfg Co, compares a large with a small model glow switch used to start fluorescent lamps. Mr Hays told the story of the switch to lighting engineers at the winter convention of the American Institute of Electrical Engineers, held in Philadelphia, Jan 27-31

of 1938, 1939, and 1940, citing improvements made. He also described the various models placed on the market, and demonstrated color differences in the so-called "white" lamp. J A McDermott, of the City of New York, spoke on the industrial application of high-voltage tubing, illustrating his talk with colored slides. A discussion on the costs of high-voltage tubing followed, with differences of opinion being expressed.

Other contributions to the conference were made by Preston Millar, who gave the results of a lighting survey. Taking an average of replies received concerning improvements and economic gains, Mr Millar pointed out that, in 125 applications reviewed, the load had decreased 96%, while the amount of light had increased 50%.

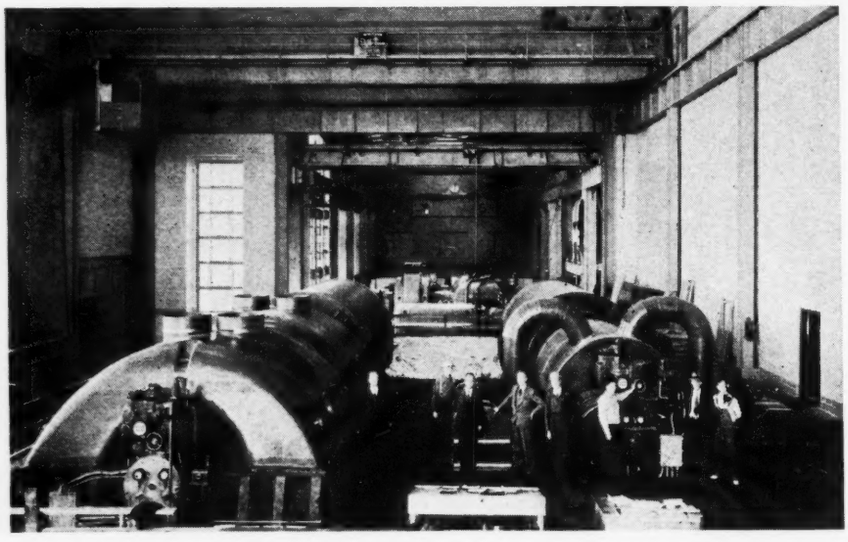
In an impressive ceremony, in the evening of Jan 29, the Edison medal was presented to Dr George A Campbell, retired research engineer, Bell Telephone Laboratories, Inc. The medal was presented to him "In recognition of his distinction as scientist and inventor, and for his outstanding and original contributions to the theory and application of electric circuits and apparatus." After the presentation an address, "After the Defense Program—A Challenge," was delivered by Charles F Wilson, president of the General Electric Co.

More Power from Niagara

Diversion of an additional 5000 cu ft of water per second at Niagara Falls by the Hydro Electric Power Commission of Ontario and plans for a $40,000,000 expansion of power-generating facilities on the Canadian side of the

(*Continued on page 122*)

ON THE LINE AT BURLINGTON



First of its type to operate at 3600 rpm, this 100,000-kw turbine-generator is pictured as it was put in service just before the turn of the year at Burlington, N. J., station of Public Service Electric & Gas Co. This unit uses 950-F steam at 1250 lb pressure, and is a cross-compound, quadruple-flow machine with hydrogen-cooled generator

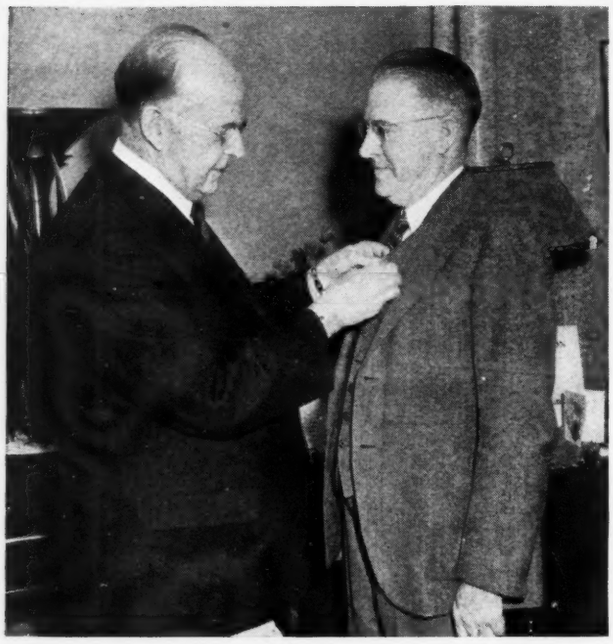
THIS picture will give you an idea of how it feels to have Nalco end the nuisance of cleaning scale out of boilers, feedlines, pumps, condensers, etc. You feel like just sitting down and taking it easy. You need not worry about corrosion, foaming, algae, nor any of the other troubles that water may cause in power plant equipment. Later, when you get accustomed to the improvement, you will undoubtedly find that the time comes in mighty handy to take care of other jobs around the plant.

Nalco offers a complete water treating service. Adoption of the Nalco System requires no additional capital investment. Let us give you the facts—no obligation.

Nalco
- the Complete Water Treating Service

NATIONAL ALUMINATE CORPORATION, 6222 West 66th Place, Chicago, Ill.

Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.



BOB DILLON HONORED

Commemorating 30 years of distinguished work with Boston Edison, Robert E Dillon, vice-president of production and engineering, recently received a service pin from Herbert W Moses, industrial relations manager. Mr Dillon's associates presented him with a marine painting on this occasion. Fred R Knight, superintendent of production, was master of ceremonies

Niagara River were announced recently by the chairman of the commission, Dr Thomas Hogg. Foundation studies are already being made for a new 50,000-hp plant on the Welland Canal at Decew Falls, near Thorold, Ont., to cost between $4,500,000 and $5,000,000, the chairman said.

The additional diversion of 5000 cu ft of water per sec at the falls has been under way since November 1, but has not been announced. In order to obtain the extra diversion, the Dominion Government agreed to put 5200 cu ft of water per second into Lake Superior from the Ogoki River.

NAPE Surveys Power Sources

Members of the National Association of Power Engineers in all parts of the United States are making a survey to determine how much energy is available in independent power plants for defense work, it was revealed by Otto L Beiswenger, president of the national association, at a recent meeting in Buffalo, N. Y.

"The Federal Power Commission is anxious to know how much power is available in the country, besides that normally provided by the public utility companies," Mr Beiswenger explained. "It is of great importance to national defense that power resources be known."

Mr Beiswenger pointed out that if the United States were subject to air attacks, such as England and Germany are undergoing now, power plants of the public utilities most likely would be prime objectives of the attackers. The current survey is designed to show national defense leaders where supplemental power is located and how it could be readily utilized if normal supplies were shut off.

40,000-kw Unit for Duke Power Co

Duke Power Co will install another 40,000-kw turbine-generator at the Buck Station, near Spencer, N. C. The new unit, to be furnished by the General Electric Co, will entail expenditures totalling three million dollars, and will be the latest type tandem-compound, double-flow, with hydrogen-cooled generator. Steam conditions will be 825 lb, 900 F, condensing.

Present capacity of Buck Station is 70,000 kw. An 80,000-kw G-E turbine generator is now being shipped for installation by July of this year. The two latest additions will bring the station's capacity up to 190,000 kw in 1942, making it the largest plant in the Duke power system.

Draft Inquiries Increase

According to information received from authoritative sources recently, inquiries concerning the drafting, for military service, of key men in industry and business are increasing rapidly. In most cases the inquiries are from persons who have not studied the act and regulations based on the act.

There seems to be a general lack of understanding that there is no blanket occupational deferment, and that each man's case is decided on its individual merits by the local draft board. On the other hand, there is no intention to handicap industry, especially those lines engaged on defense projects. It is also stated that no deferment can be for more than six months, although in special cases extensions of this maximum period may be obtained.

Where local boards cannot be convinced of the importance of key men to an industry, appeal may be made to the state headquarters of the selective service board. Before this is done, it is important that volume 3 of the Selective Service Act should be obtained from the local board and studied.

Bill Authorizes New Hydro Plant

Representative Fred Bradley, (R. Mich.,) has introduced a bill in Congress authorizing construction of a new hydroelectric power plant on the St Marys River at the foot of the falls at Sault Sainte Marie, Mich., and abandonment of the present plant.

His bill provides that the project be built to produce the greatest amount of economic power and that the power be sold by the War Dept under rates approved by the Federal Power Commission. Estimated cost of the new plant is fixed at $10,000,000. The present plant is operated by a private concern.

OBITUARIES

JAMES H HURLEY, 79, oldest employee of Terry Steam Turbine Co, died on Feb 2. His connection with the turbine industry goes back to very beginning of turbine-building in the United States. He started to work for E C Terry, inventor of the Terry turbine, in the late 1880's. Up until a few years ago Mr Hurley was engaged in the erection and service work of Terry turbines.

W RODMAN PEABODY, 66, a director of Mutual Boiler Insurance Co, and Walworth Co, Boston, Mass., died at his home in Milton, Mass., on Jan 12. He was known as one of the foremost public utility executives and lawyers in the northeast.

CHARLES A GREENIDGE, 68, retired vice-president and chief engineer of the Utility Management Corp, operating subsidiary of the Associated Gas &

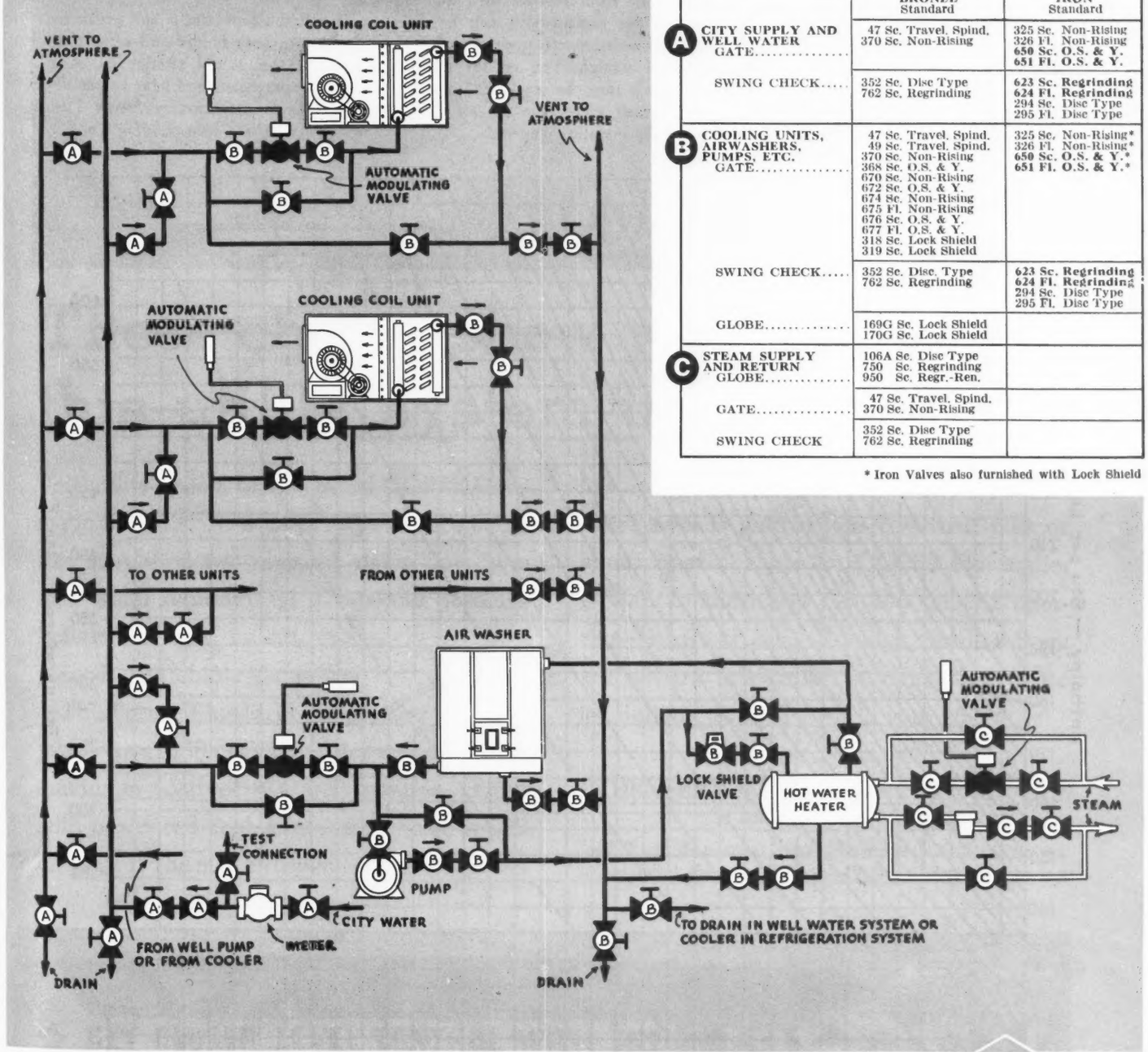
(Continued on page 176)

. . TO GOOD VALVE *PRACTICE* . .

FOR AIR CONDITIONING SYSTEMS . . .

Jenkins RECOMMENDS . . .

INDUSTRIAL PLANT



REFERENCE CHART FOR JENKINS FIGURE NUMBERS

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A	CITY SUPPLY AND WELL WATER GATE	47 Sc. Travel. Spind. 370 Sc. Non-Rising	325 Sc. Non-Rising 326 Fl. Non-Rising **650 Sc. O.S. & Y.** **651 Fl. O.S. & Y.**
	SWING CHECK	352 Sc. Disc Type 762 Sc. Regrinding	**623 Sc. Regrinding** **624 Fl. Regrinding** 294 Sc. Disc Type 295 Fl. Disc Type
B	COOLING UNITS, AIRWASHERS, PUMPS, ETC. GATE	47 Sc. Travel. Spind. 49 Sc. Travel. Spind. 370 Sc. Non-Rising 368 Sc. O.S. & Y. 670 Sc. Non-Rising 672 Sc. O.S. & Y. 674 Sc. Non-Rising 675 Fl. Non-Rising 676 Sc. O.S. & Y. 677 Fl. O.S. & Y. 318 Sc. Lock Shield 319 Sc. Lock Shield	325 Sc. Non-Rising* 326 Fl. Non-Rising* **650 Sc. O.S. & Y.*** **651 Fl. O.S. & Y.***
	SWING CHECK	352 Sc. Disc. Type 762 Sc. Regrinding	**623 Sc. Regrinding** **624 Fl. Regrinding** 294 Sc. Disc Type 295 Fl. Disc Type
	GLOBE	169G Sc. Lock Shield 170G Sc. Lock Shield	
C	STEAM SUPPLY AND RETURN GLOBE	106A Sc. Disc Type 750 Sc. Regrinding 950 Sc. Regr.-Ren.	
	GATE	47 Sc. Travel. Spind. 370 Sc. Non-Rising	
	SWING CHECK	352 Sc. Disc Type 762 Sc. Regrinding	

* Iron Valves also furnished with Lock Shield

NEXT MONTH: WATER SERVICE SYSTEMS

#27 OF A SERIES designed to help in your selection of **JENKINS VALVES**

Prompt delivery of Jenkins Valves from reliable supply houses everywhere

JENKINS BROS., REG. U.S. PAT. OFF. TRADE JENKINS MARK Jenkins Bros. BRIDGEPORT, CONN.

Number 104

Heat—Temperature—Entropy Chart for Air

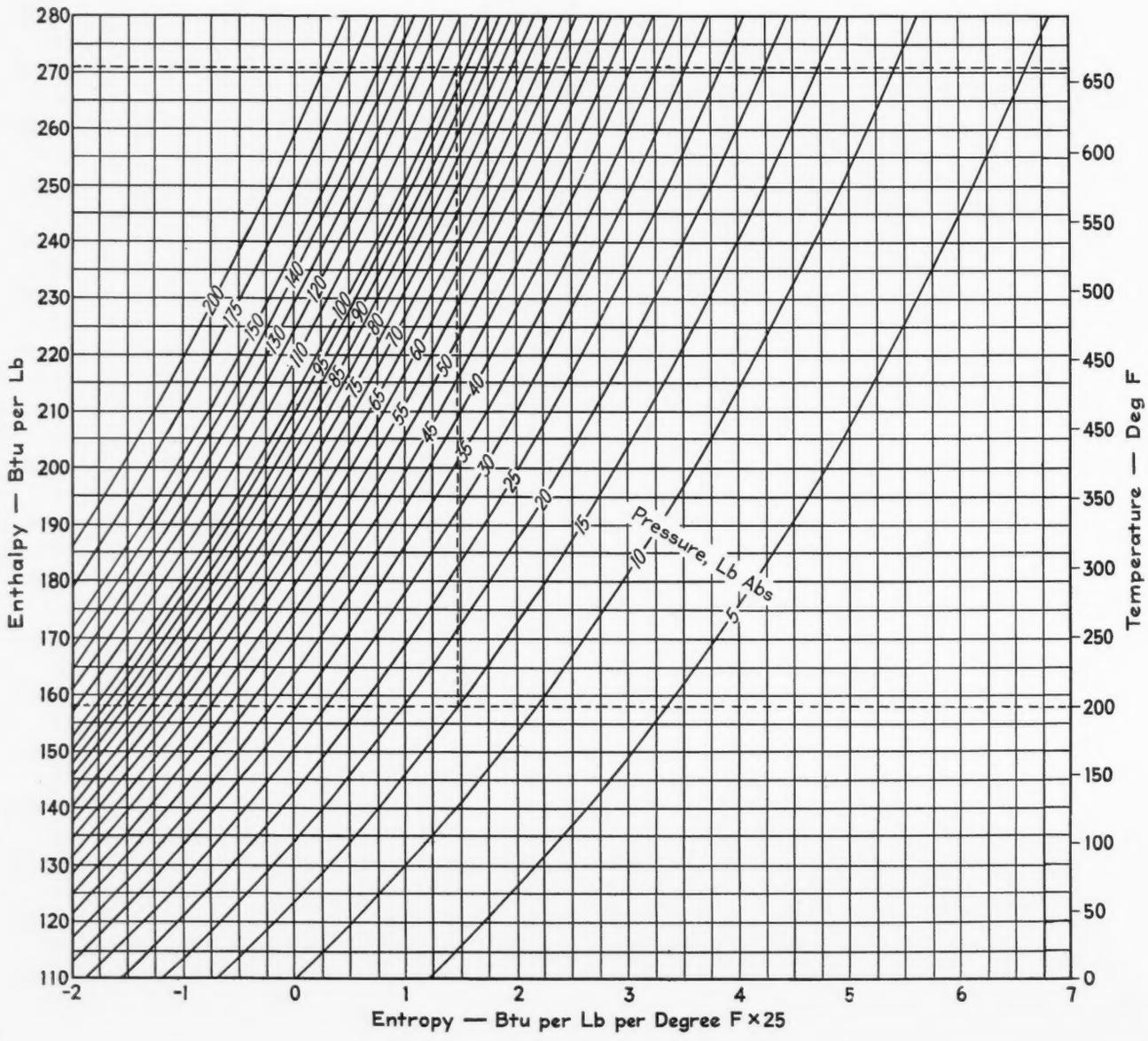
▶ JUST AS A MOLLIER DIAGRAM for the properties of steam facilitates some of the usual computations required for determining turbine performance, a similar plot for the properties of air is useful for certain compressor, intercooler and aftercooler computations. The chart, of which a low-temperature section is shown here, was originally developed up to 2000 F for gas-turbine computations. The data, however, apply equally to normal compression or cooling at ordinary temperatures.

Unlike the steam chart, an air temperature scale can be plotted directly alongside (right) the same curves as the heat content, enthalpy (left). To find the condition of air at any given temperature and pressure (absolute), one need only find the temperature on the right-hand scale and move left to the proper pressure curve. The heat content is given directly on the left-hand scale in Btu per lb.

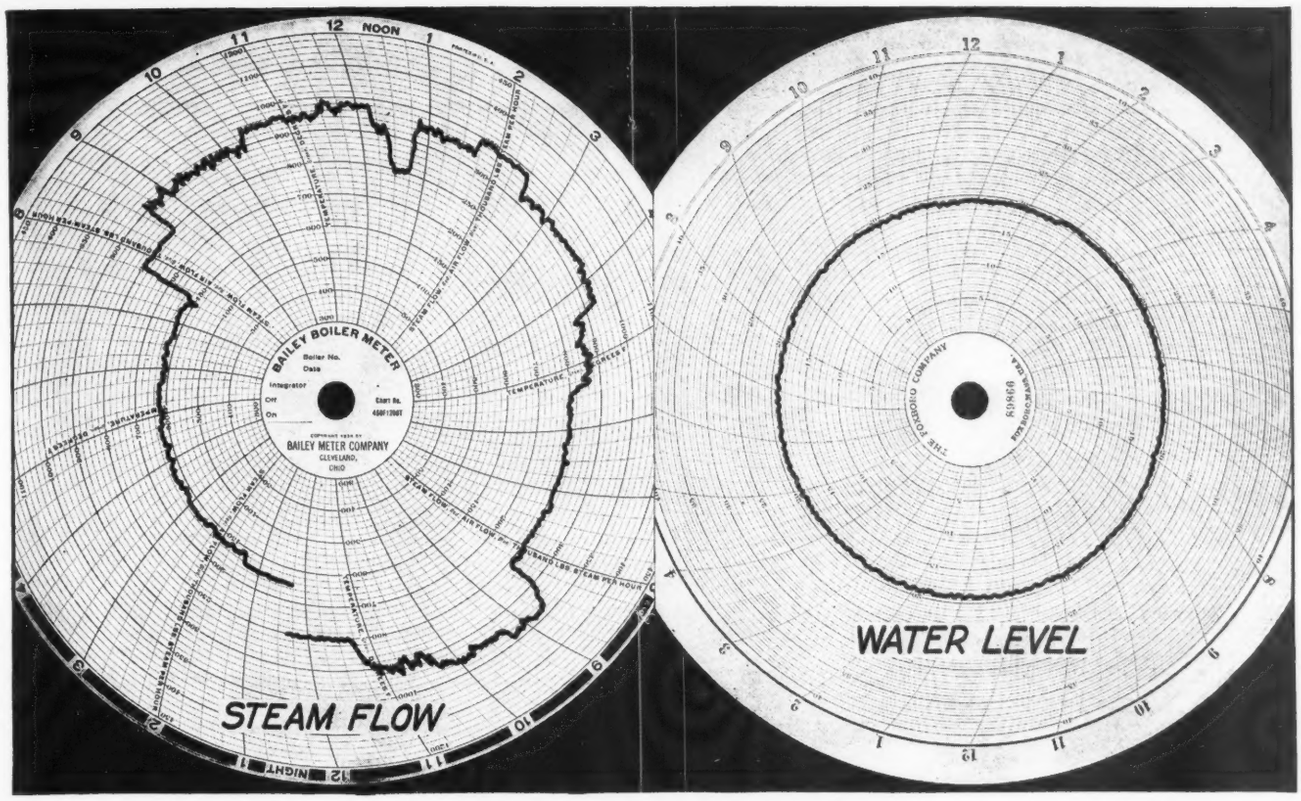
For approximating the work of compressing air from a lower to a higher pressure, the compression can be assumed to be adiabatic, represented by a vertical straight line on the chart. The work is then the mechanical equivalent of heat gained by the air, 2545 Btu per hr equaling one hp.

Example: Assume 100 lb per hr of air compressed adiabatically from 200 F and 15 lb abs to 100 lb abs. Final temperature will be 660 F (see dotted lines). Final enthalpy is 271 Btu, original enthalpy 158 Btu, a difference of 113 Btu. Work of compression = $113 \times 100 = 11{,}300$ Btu per hr. Theoretical hp required = $11{,}300 \div 2545 = 4.44$ hp.

If actual temperatures and pressures are known, both before and after compression, the actual change of state can be represented and heat values determined.—*Chart courtesy Steam Turbine Dept, Allis-Chalmers Mfg Co.*



© POWER



These charts show why 6 plants in this utility system use Flowmatic

This utility system first installed COPES Flowmatic in 1937. Now six of its plants are using this simplified two-element steam-flow type feed water regulator on 875-pound pressure boilers. Seven repeat orders have been placed. The charts show why.

This Foster Wheeler 3-drum boiler normally evaporates 330,000 pounds per hour, with maximum load of 400,000 pounds. Fired with powdered coal, total temperature is 860 degrees F. The motor-driven centrifugal pump has no automatic pressure control, yet the water level is held within less than plus or minus one inch by the COPES Flowmatic.

Want to know how this new COPES operates—where it is used—what results others are getting in regular service? Then write for Bulletin 429. It's worth your study!

NORTHERN EQUIPMENT COMPANY
311 GROVE DRIVE, ERIE, PA.

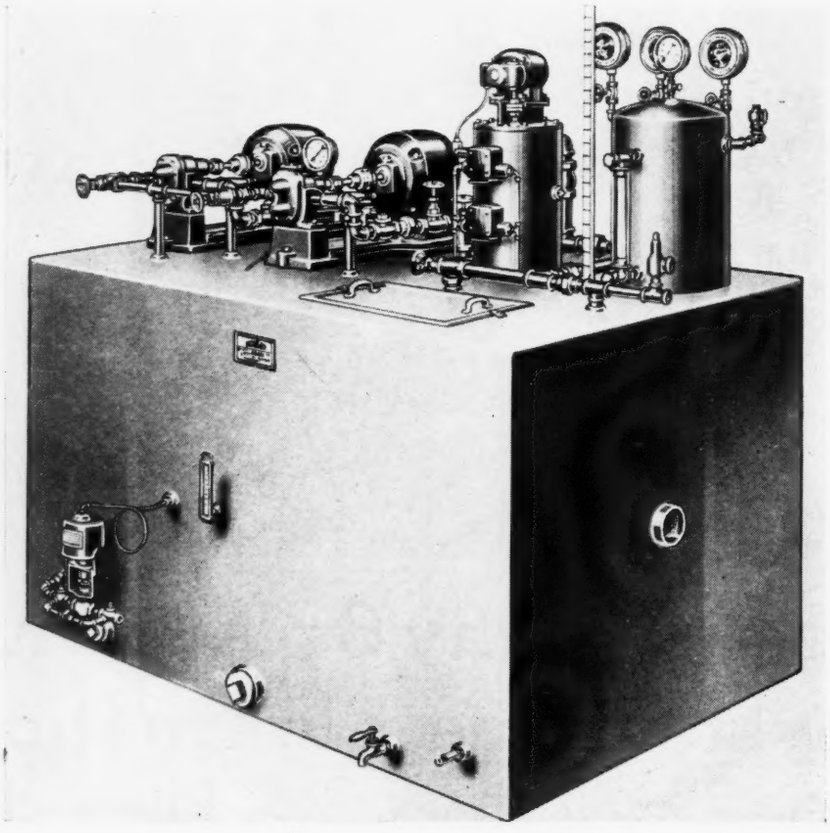
Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters

★ GET CLOSER LEVEL CONTROL WITH THE COPES FLOWMATIC ★ REGULATOR

FEEDS BOILER ACCORDING TO STEAM FLOW-AUTOMATICALLY

WHAT'S NEW IN PLANT EQUIPMENT

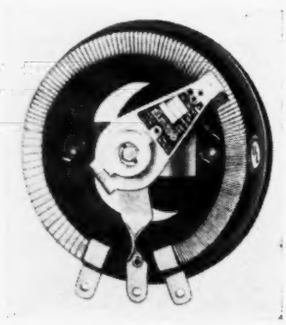
Lubrication Units



SELF-CONTAINED LUBRICATION SYSTEMS have all pipes, pumps, lubricators, etc, in one unit, and all that is necessary to put units into operation is to hook up pipelines and connect wiring. Units made in various sizes to suit individual requirements, some models having alarms to indicate if oil is not being supplied to a machine, or if pressure filter needs cleaning. Models available in capacities from 2 to 25 gpm. Various accessory equipment, such as sight-flow indicator, sight-feed oiler, pressure-regulating valve, etc, can be added to systems at small extra cost. Electric gong, pressure gages, pressure switches, valve-control system, and mill stand assembly are furnished as standard equipment, at no extra cost, with all systems. *S F Bowser & Company, 1302 East Creighton Avenue, Fort Wayne, Ind.*

Generator Rheostat

OHMITE FIELD RHEOSTATS are tapered or uniformly wound, as desired, designed to provide control for separately or self-excited generators. Available in series of 10-watt sizes, from 25 to 1000 watts. By providing practically continuous variation of resistance in smallest sizes, they effect saving in control-panel space. *Ohmite Mfg Co, 4835 Flournoy St, Chicago, Ill.*

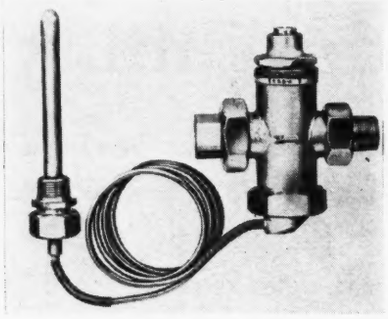


Copper

ROCAN COPPER is available in standard stock sizes in sheets, rolls, and strips, which are applied in same manner as commercial sheet copper. Since introduction of electrolytically refined copper to trade, comments have been made regarding copper applied to roofs, that under certain conditions copper was not as good as it was previously. After investigation, it was found that corrosion fatigue was the cause, in many instances, of failure. Company's research dept found that electrolytic refining removes, along with other impurities, certain elements which tend to prolong the life of copper roofing and sheet metal work. By the re-introduction of some of these minor constituents in controlled amounts, material is obtained which forms a better protective film. Tensile strength of new material, as well as its endurance limit in corrosion fatigue, is said to be substantially higher than that of electrolytic copper. *Revere Copper & Brass, Inc, 230 Park Ave, New York, N. Y.*

Temperature Controls

NEWEST CONTROL in line is direct-acting thermostatic control for tank and process applications to regulate flow of steam or water. Its function is to provide a modulating flow of water, steam, or gas, and to control temperature within 1½ deg F, plus or minus. In operation, thermal bulb is installed in either tank or liquid line. Change in temperature at bulb increases or decreases pressure within bulb. This pressure-change is transmitted through copper capillary tubing to bellows at bottom of valve housing. Pressure in turn is transmitted to valve stem, opening and closing valve. Standard thermal bulb is copper for immersion in non-corrosive liquids. Bulbs with protective shields of special metals or special plating to resist various corrosive solutions are available. Standard low pressure control is tight-closing, single-seated and semi-balanced, with corrosion-resistant bronze valve disk and seat. High-pressure control is of same design with stainless-steel valve disk, seat and stem. *Sterling, Inc, 3732 N Holton St, Milwaukee, Wis.*



Unit Heater

DOWNBLAST SPEED HEATER supplements company's line of floor-type and standard suspended heaters. Although particularly suited for high installations, heater is not limited to them. Where a comparatively low installation is desired, deflection cones, illustrated, are left on, resulting in wider diffusion of heated air stream and tempera-

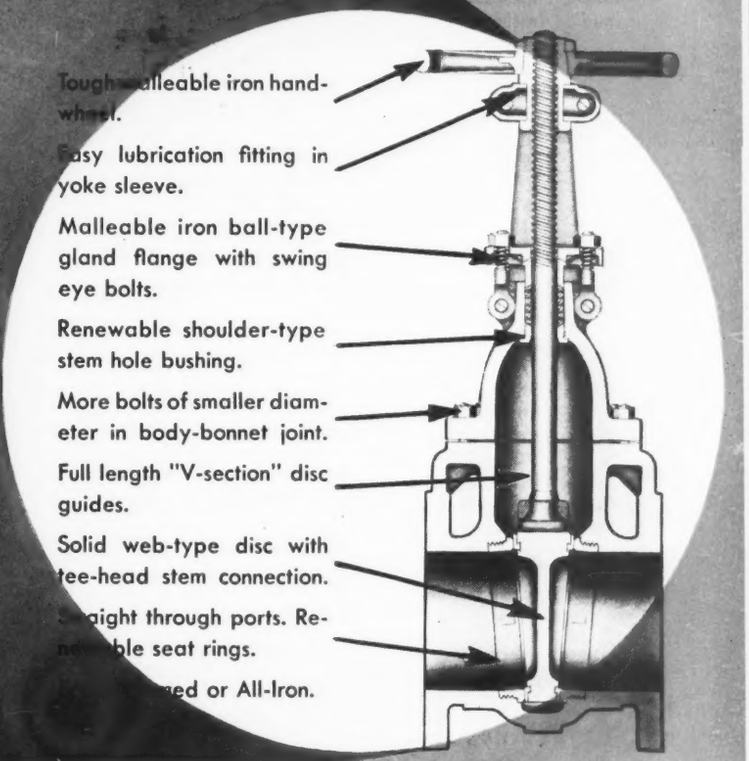
A NEW, IMPROVED LINE OF IRON BODY WEDGE GATE VALVES

FOR 125 POUNDS STEAM, 200 POUNDS COLD WATER, OIL OR GAS

Advanced design throughout these valves increases adaptability for service and minimizes maintenance in severest usage. Made in all types: Non-Rising Stem . . . Outside Screw and Yoke . . . Quick-Opening . . . Underwriters' Patterns . . . Marine Cargo Oil System Valves. Also in Alloy Cast Iron. Flanged, screwed, or hub ends.

Catalog giving complete specifications on the entire line is available from your Crane Representative or by mail request.

NEW FEATURES LIKE THESE IN ALL PATTERNS


Tough malleable iron hand-wheel.
Easy lubrication fitting in yoke sleeve.
Malleable iron ball-type gland flange with swing eye bolts.
Renewable shoulder-type stem hole bushing.
More bolts of smaller diameter in body-bonnet joint.
Full length "V-section" disc guides.
Solid web-type disc with tee-head stem connection.
Straight through ports. Renewable seat rings.
ed or All-Iron.

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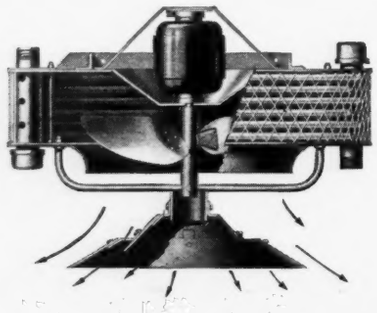
VALVES • FITTINGS • PIPE • PLUMBING • HEATING • PUMPS

NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

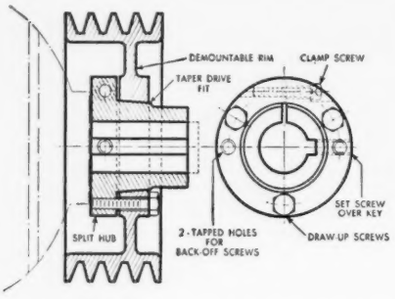
ture reduction in working level. For high installations, deflection cones can be removed easily to obtain greater downward velocity of heated air. Structurally heater consists of a circular extended-surface heating element protected by screen guard,



with copper tubes brazed into copper headers. Fins are aluminum for maximum heat transfer. Headers have threaded connections at either end, allowing steam lines to be connected to whichever side is most convenient. *B F Sturtevant Co, 47 Readville St, Hyde Park, Boston, Mass.*

Detachable Sheaves

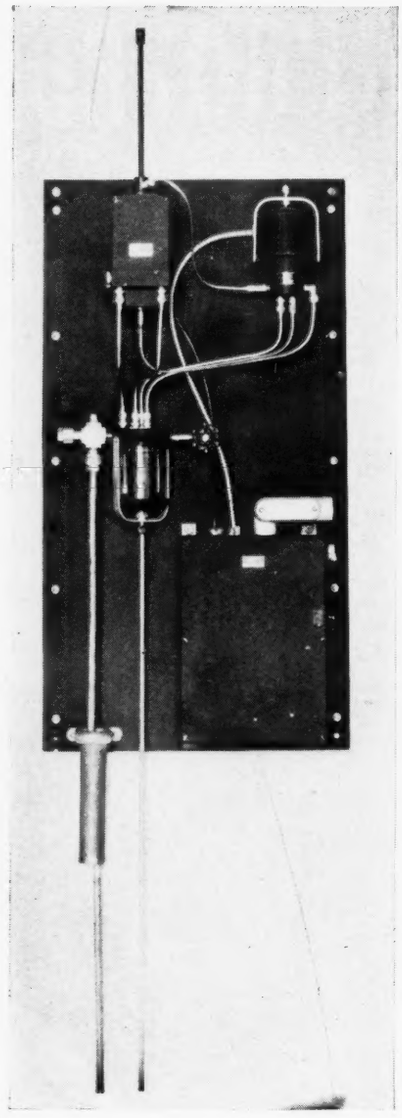
V-BELT DRIVER SHEAVE eliminates, according to maker, necessity of wheel-puller to remove wheel or hub from shaft to get at driving unit. Each sheave unit consists of two parts, a longitudinally split or clamp hub and V-grooved rim. Hub is clamped to shaft by means of cap screw in its flange and is fastened by standard keyway. Rim



is taper-fitted to hub and is fastened with three draw-bolts. To remove rim, all bolts are withdrawn and two are inserted in holes so tapped in rim that bolts act as jamb screws and bear against hub, thus forcing the rim off taper without disturbing position of hub. No pounding or prying is required to remove either rim or hub. *Worthington Pump & Machinery Corp, Harrison, N. J.*

Controlled-Atmosphere Oxygen Recorder

CAMBRIDGE OXYGEN RECORDER has been designed to produce continuous record of oxygen percentage in furnace atmospheres. Instrument is automatic, and can be furnished with contacts for providing automatic control or actuating alarm circuits. In essentials, analysis cell consists of four



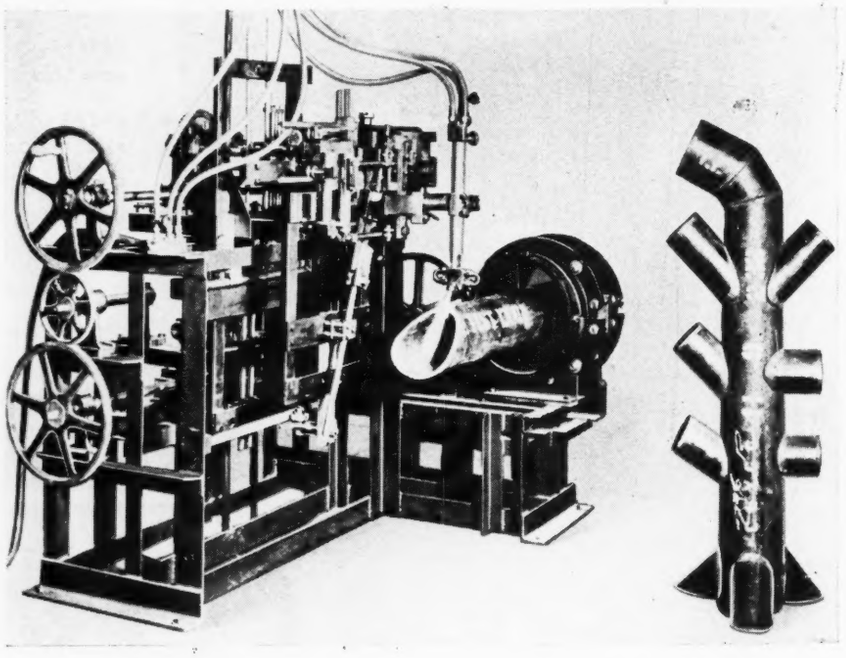
identical fine platinum spirals in two cells contained in metal block. Spirals are heated by passing equal electric currents through them, and when both cells contain the same gas, four spirals reach same temperature. If oxygen in gas in one cell is replaced by an equal volume of CO_2, spirals in that cell will become hotter than the other, difference in temperature being proportional to CO_2-concentration increase in the cell. Recorder galvanometer is connected to two sets of spirals in such a way that its deflection is a measure of the difference in their temperatures, and, therefore, of the difference in composition between gases in two cells. Gas stream is passed first to one cell in meter, through furnace, and then to second cell. Furnace contains a rod of hard carbon steel heated to combustion temperature so that during its passage through furnace, any oxygen in gas is converted to CO_2. Change in CO_2 concentration between two cells and current in galvanometer are proportional to oxygen concentration of original gas. *Cambridge Instrument Co, Inc, 3732 Grand Central Terminal, New York, N. Y.*

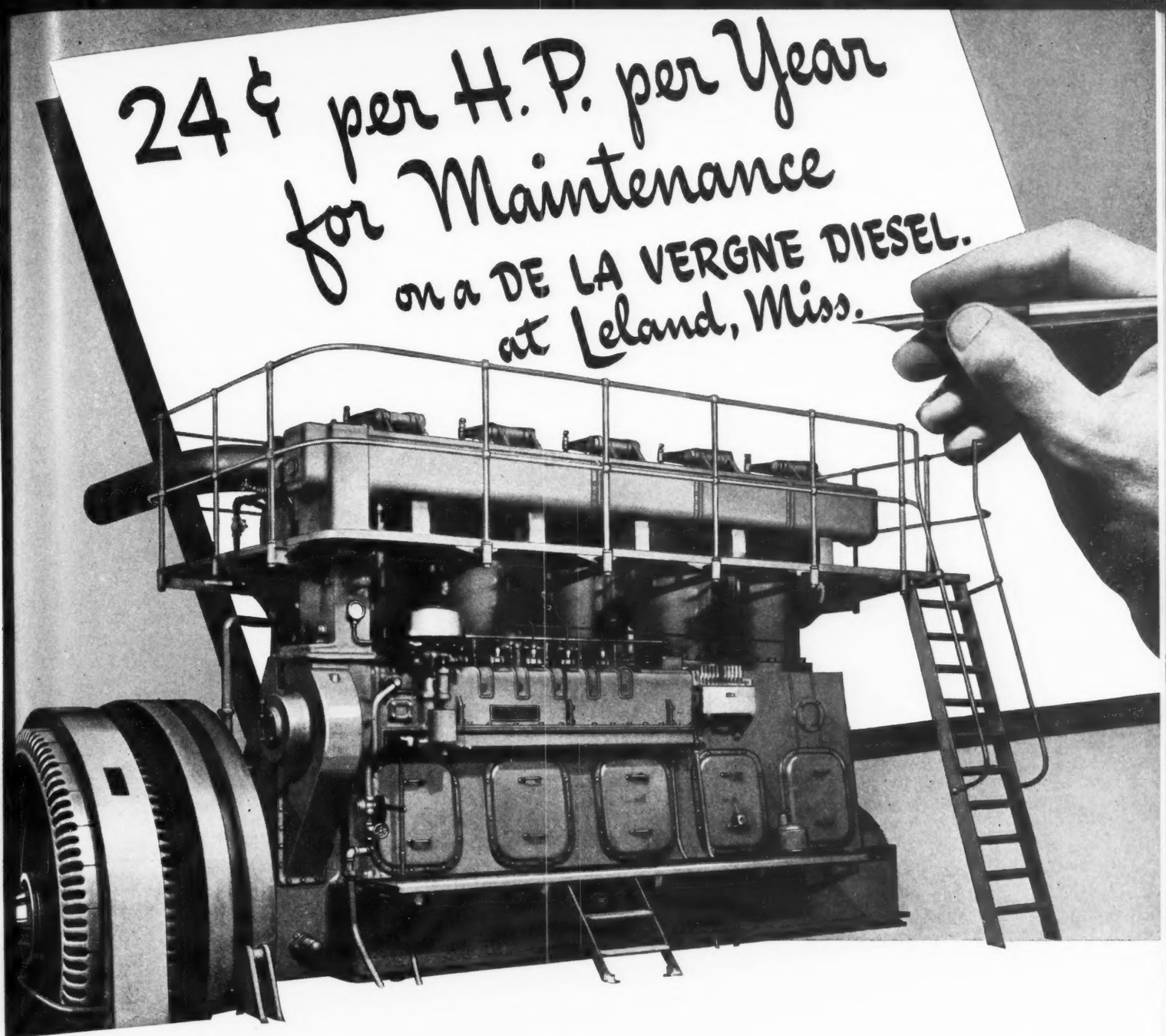
Adjustable Lamp Socket

"SWIVELIER" LAMP SOCKET is adjustable to full 90 deg, and can be rotated to describe complete circle when adjusted at any angle. Sockets available in three standard finishes, dipped brass, brush brass and electro nickel. Wires cannot twist in sockets, due to special stop, and patented construction permits unit to stay put after being adjusted. Said to be only completely adjustable swivel socket with any regular type of electrolier mechanism: push through, pull chain, keyless, turn knob, or 3-way. *Reliance Devices Co, 140 Liberty St, New York, N. Y.*

Pipe Intersection Cutter

"FALL-O-MATIC" MACHINE will cut any size pipe to fit any pipe of same size, or larger, at any angle or offset. In illustra-





Installed in 1930 this 625 hp De La Vergne diesel engine has operated a total of 34,000 hours at the Leland, Miss., municipal light plant. During this period the entire cost of repairs has amounted to $1500.

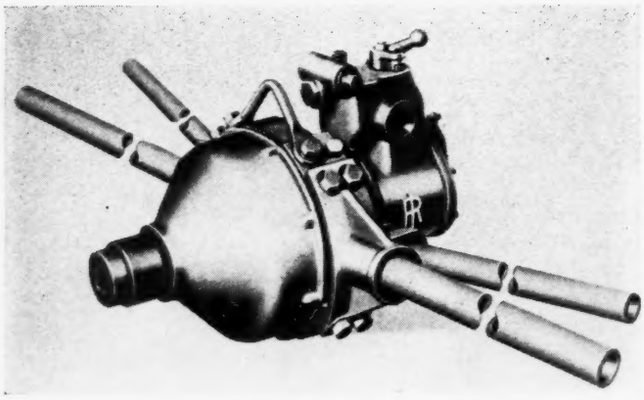
De La Vergne diesel engines are available in sizes from 200 hp to 1,500 hp. Quietness, dependability and economical operation can be yours with a De La Vergne.

Baldwin De La Vergne Sales Corp., subsidiary of The Baldwin Locomotive Works, Philadelphia; Pacific Coast Representative, The Pelton Water Wheel Co., San Francisco.

Baldwin De La Vergne Sales Corp.

BLW THE BALDWIN GROUP

DIVISION OF THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA



tion, a piece of 6-in. pipe has been cut to fit an 8-in. pipe at an angle of 45 deg, with a 1-in. offset. Cutting is by standard torch. Machine is hand operated because compound motion changes cutting speed to such an extent that operator must gage speed to match torch's ability to cut. *Spence Engineering Co, Inc, Walden, N. Y.*

Flue-Rolling Machines (above)

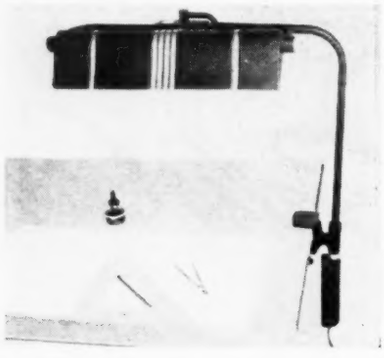
SIZES 55-Q AND 55-R FLUE-ROLLING MACHINES powered by "Multi-Vane" type air motor. Constructed especially for rolling extra large tubes, tapping for, running in or removing large pipe plugs, tapping flue sheets in boilers, and for heavy reaming. Size 55-Q has average working speed of 32 rpm, while size 55-R has working speed of about 20 rpm, with 50% greater torque. *Ingersoll-Rand Co, Phillipsburg, N. J.*

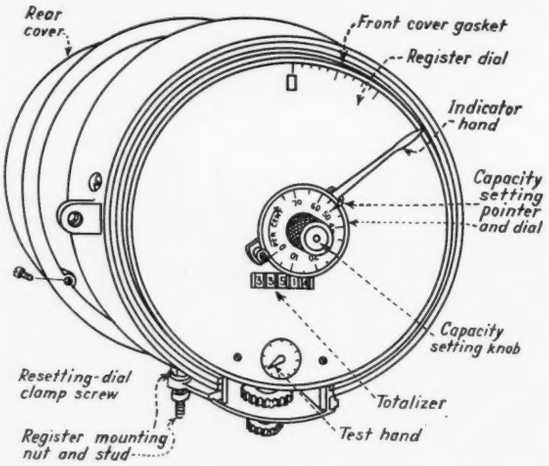
Temperature Indicator

PORTABLE INSTRUMENT for thermocouple temperature measurements is also used for checking thermocouples and small emf's. Increased accuracy has been provided by calibrating only a small portion of range on continuously adjustable slidewire. The remainder, adjustable on fixed steps, is on a dial switch of ten resistors. No additional accessories required, except thermocouple and an ice bath for reference-junction. *Leeds & Northrup Co, 4934 Stenton Ave, Philadelphia, Pa.*

Engineer's Light

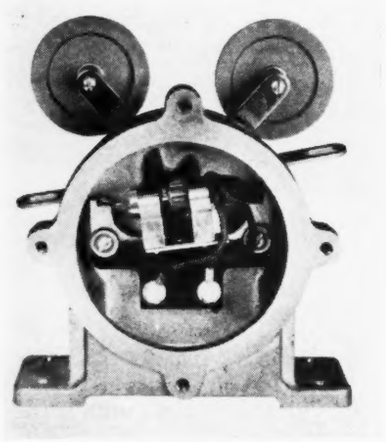
FLUORESCENT LAMP has special pigment-treated reflector which balances blue light common in lamp and produces neutral colorless light. Quick adjustments enable swivel arm to be set at any position from table top to 24 in. Shade is adjustable in horizontal arc 360 deg and in a vertical arc 180 deg. Illustration shows model 2224A, fastened to drawing surface by clamp. Auxiliary ballast is placed at end of swivel arm, below level of drawing table. *Frederick Post Co, P O Box 403, Chicago, Ill.*





Float Switch

SWITCH USES snap-action mercury contactor, and is built entirely of non-corrosive materials. Designed and packaged for field man, unit comes complete with bracket for wall mounting, plus two wood screws and two expansion shields, or it may be used on pipe for floor mounting, using furnished U-bolt. Float, counterweight and cable all included in package. *Automatic Control Co, 1005 University Ave, St. Paul, Minn.*



Conductive Rubber

COMPOUNDING of rubber and synthetic rubber produces substance that, according to company, has "an electric resistivity possibly as low as one-millionth that of ordinary rubber". New product is used for applications where static electricity is present, and where danger exists if sparks are allowed. Charges made by static electricity pass harmlessly through compound, it is said. New methods evolved by company laboratories for pigmenting and mixing conductive ingredients with rubber and synthetic rubber are used in these applications. *B F Goodrich Co, 460 South Main St, Akron, Ohio.*

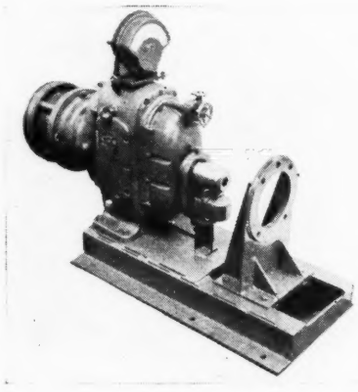
Recycling Control (above)

PERMUTIT RECYCLING control is for attachment on meters used for initiation of automatic processes. Control is so constructed that when predetermined amount of water has passed through meter, contact will be made which will start automatic cycle, after which meter control resets itself and is ready to measure predetermined quantity of water before next automatic cycle is started. No electrical current-carrying parts are on dial. Adjustment of quantity of water that will pass through the meter between automatic cycles is accomplished by means of easily-accessible dial visible through glass face, as are totalizer, test hand and register dial. *Permutit Co, 330 W 42nd St, New York, N. Y.*

Variable-Speed Test Rig

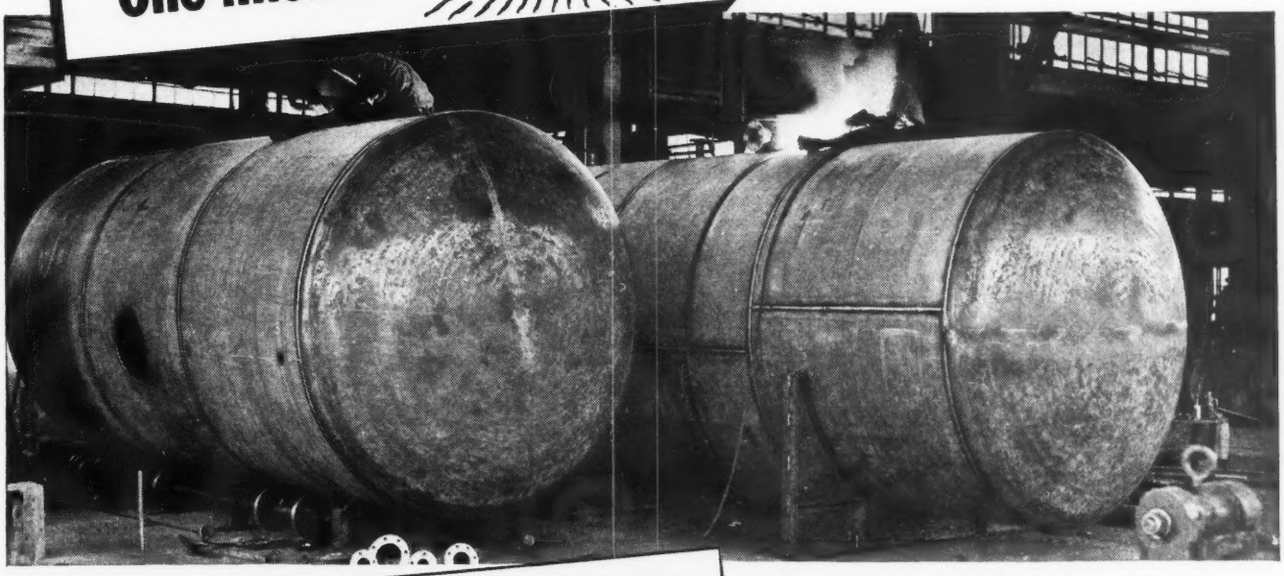
COMPACT, FULLY-ENCLOSED VARIABLE-SPEED TEST RIG combines basic PIV unit and adjustable mounting bracket on a rigid welded-steel base. Can be used for testing generators, governors, vibrators, pumps, etc, where tests are made to determine

(*Continued on page 148*)



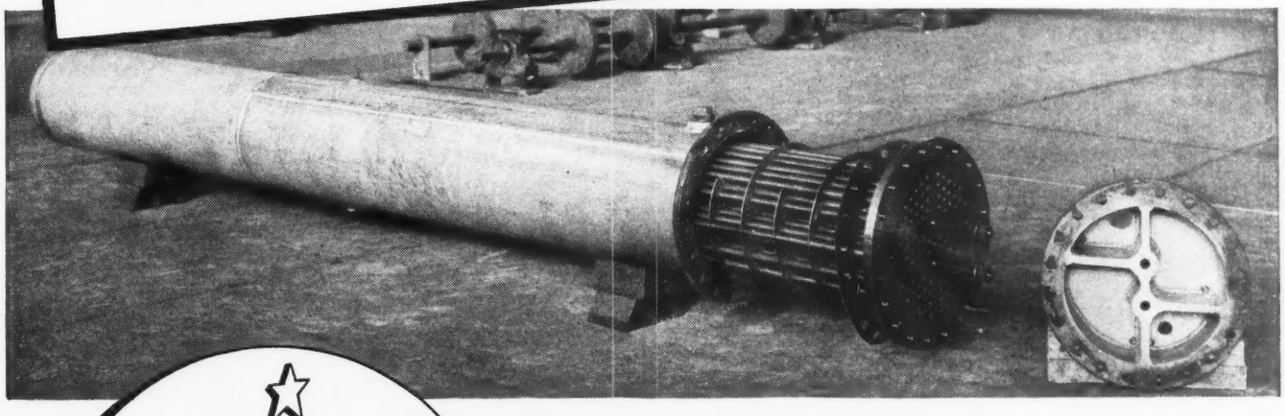
One likes it HOT

HOT WATER Storage Heaters, 10,000 gals. each, made of solid Everdur for Mary Immaculate Seminary, Northampton, Pa., by Patterson-Kelley Co., Inc., East Stroudsburg, Pa.



One likes it COLD

FREON WATER COOLER, also fabricated by Patterson-Kelley. Shell, tube sheets and baffles are of non-rust Everdur. Queens County Court House, N. Y., will use it.



Both choose EVERDUR!

EACH YEAR, more and more plant and property owners discover the real economy of equipment made of non-rust Everdur copper-silicon alloy. For Everdur not only eliminates periodic, expensive rust repairs and eventual replacement due to rust . . . but it also assures a lasting freedom from red, rusty water.

Easy, economical fabrication

The advantages of Everdur are not costly. Everdur can be easily and economically fabricated by all common construction methods, including oxy-acetylene and electric welding.

Any of the leading equipment fabricators will be glad to quote you on Everdur construction. 4055

Everdur TANK METAL

ANACONDA from mine to consumer

THE AMERICAN BRASS COMPANY, General Offices: WATERBURY, CONNECTICUT
In Canada: **ANACONDA AMERICAN BRASS LTD.,** New Toronto, Ont. • *Subsidiary of Anaconda Copper Mining Co.*

"EVERDUR" is a trademark of The American Brass Company, registered in the United States Patent Office.

ENGINEERS' BOOKSHELF

DIRECTORY OF ELECTRIC GENERATING PLANTS AND MAP OF PRINCIPAL PLANTS AND TRANSMISSION LINES IN THE UNITED STATES *(1941). Published only by Federal Power Commission, Washington, D. C. Price $1.00, which includes 27x42-in. map. A 4½x7-ft map is sold separately at $2.50 unmounted and $5.00 mounted on linen.*—The directory lists all electric utility generating plants in the U. S. of 1000 kw or more installed capacity, and classifies them by age and size. The aggregate capacity of these plants, of which there are 1922, is 39,503,445 kw, comprising more than 98% of the country's central-station capacity.

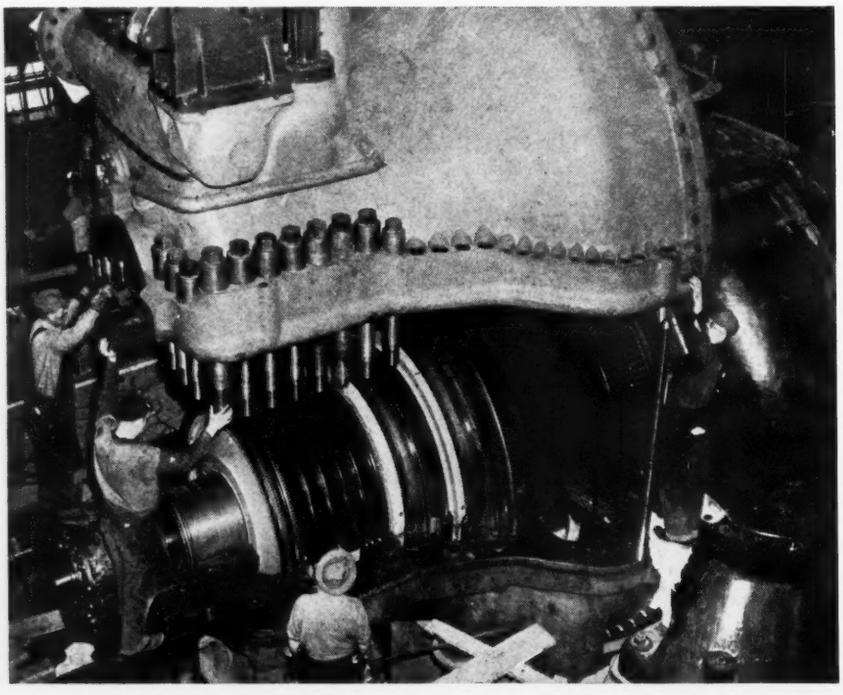
Plants are classified by type of prime mover—steam, hydro, or internal-combustion—and are grouped according to classes of ownership in each state. In addition to information identifying each plant, data shown include capacity, generation, fuel and fuel-cost for fuel plants and gross static head for hydro plants, number of employees, and period of installation for generators and prime movers.

The maps, either the small size that accompanies the directory or the large wall size, show ownership of generating plants and transmission lines by identifying numbers corresponding to numbers in the directory. Size of plants is indicated by symbols and transmission-line voltages are shown by colors. Existing facilities and those under construction are shown, as are classes of ownership, whether public or private, and types of prime movers.

HEAT TRANSFER BY RADIATION. *By W J Wohlenberg, Sterling Professor, Mechanical Engineering, Yale University. Published by Engineering Experiment Station, Purdue University, Lafayette, Ind. Price $.25.*—Consists of a series of lectures presented at Purdue University on April 23 and 24, 1940, and reprinted because of numerous requests. Topics covered are: "The Nature of Radiation and Its Net Interchange between Surfaces of Solids", "Spectral Distribution of Energy and Radiation from Gases", "Equations Representing the Net Interchanges by Radiation Occurring in Systems Involving Gases With and Without Particles in Suspension", and "Distribution of Energy in the Pulverized Coal Furnace Cavity."

MECHANICAL WORLD YEAR BOOK *(1941). Published by Emmott & Co, Ltd, 31 King St West, Manchester 3, England. 266 pages, tables, formulas, pages for notes and sketches, engineering information. Price 2 shillings (approximately $.50).*—In addition to regular and useful engineering tables and information, latest edition has new sets of tables for all the more familiar ball and roller bearings. New formulas permit quick ascertainment of bearings required for definite service conditions and for any speed. New matter also included on case-hardening processes.

POTENTIAL POWER



Workmen are shown lowering upper half of casing onto a huge 107,200-hp steam turbine in Central New York Power Corp's new $16,500,000 station at Oswego, N. Y. Note the giant bolts which seal the casing against the 1250-lb, 900-F steam used in the turbine. Now in operation, the machine will be teamed in about six months with another of similar size

ANNUAL REPORT — WELDING RESEARCH COMMITTEE OF THE ENGINEERING FOUNDATION. *Published by the Welding Research Committee, 29 West 39th St, New York, N. Y. No price listed.*—This pamphlet contains a brief report of the committee for 1940, together with brief statements concerning the various divisions. A list of members, researchers and current subscribers is included for reference.

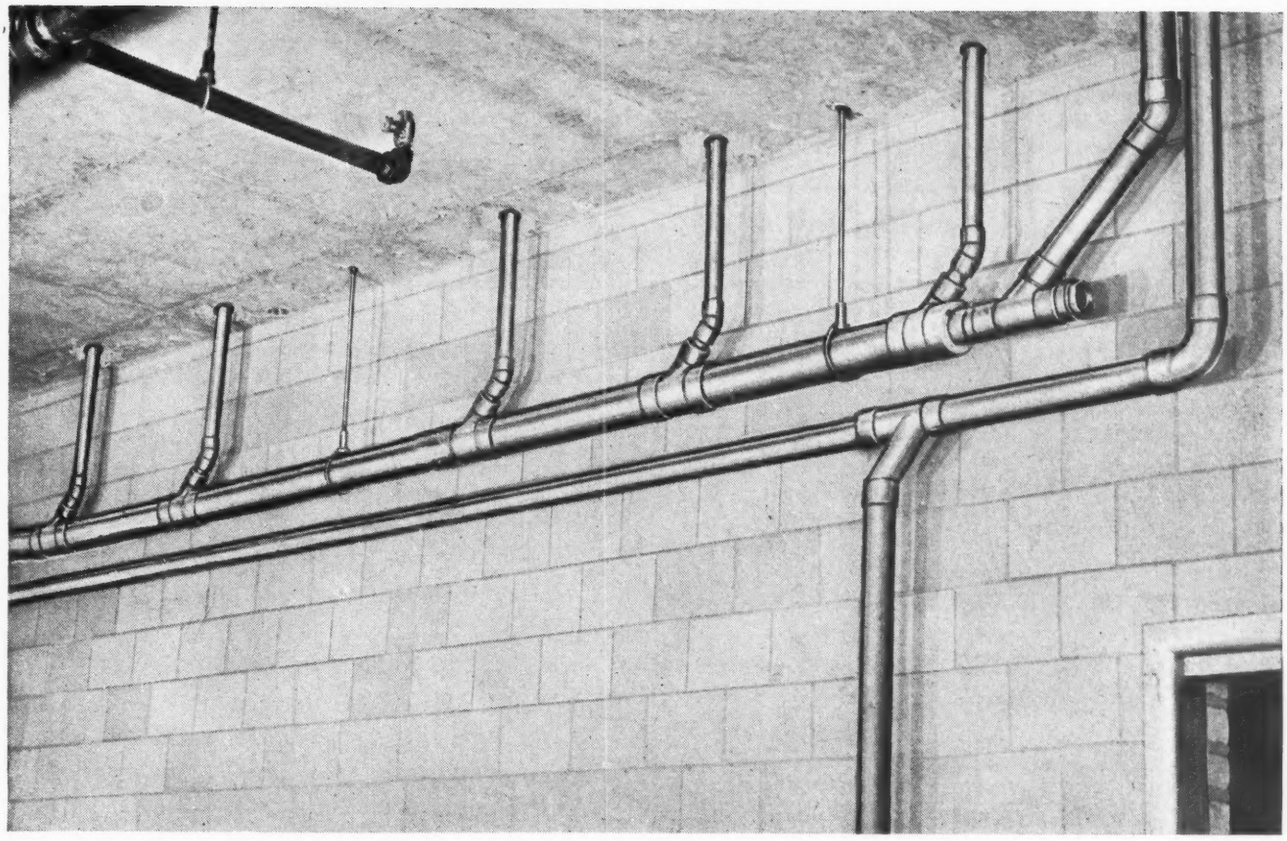
DIRECTORY OF ASSOCIATION MEMBERS (6th Edition, 1941). *Published by Association of Consulting Chemists and Consulting Engineers, 50 East 41st St, New York, N. Y. Available on request.*—Consists of a list of members arranged alphabetically and a list arranged geographically. Has single-page statements from each member covering his and his organization's qualifications in handling specific and general problems, and key sheet, whereby user can find type of work in which he is interested and, from the corresponding numbers, select the firms qualified to help him solve problems connected with that work.

THE RECOVERY OF SULPHUR DIOXIDE FROM DILUTE WASTE GASES BY CHEMICAL REGENERATION OF THE ABSORBENT. *Report of investigation conducted by H Fraser Johnstone and Alamjit D Singh, Engineering Experiment Station, University of Illinois. Price $1.00. Published by the University of Illinois, Urbana, Ill.*—Process is described for the recovery of sulphur dioxide from dilute gases which depends on regenerating the absorbing solution by treatment with zinc oxide. Data obtained is presented in detail so that complete design estimate can be made for full-scale plant.

SCALE FORMATION IN WATER HEATERS AND METHODS OF PREVENTION. *By J M Krappe, Associate in Gas Engineering, Purdue University. Published by Purdue University, Lafayette, Ind. Price $.25.*—Report may be considered as an extension of research on the application of gas fuel to water heating. Material is a summary of results of accelerated scale-formation tests performed on gas-fired water heaters at various times during last two years. It also includes a summary of field experiences with hard-water scale formation and suggested designs for feeders to supply scale-inhibiting material.

LEFAX DATA. *Published by Lefax, Inc, Philadelphia, Pa.*—The following bulletins of interest to POWER readers have been received: No. 12-85, "Underfeed Stokers", No. 35-57, "Code for Design and Installation of Mechanical Warm Air Heating Systems", and No. 37-11, "Gravity Warm-Air Heating Systems".

EDUCATIONAL CALENDAR. *By Leighton A Wilkie, Continental Machines, Inc, 1201 Thatcher St, DesPlaines, Ill.*—Very large calendar consisting of 12 posters outlining basic principles of machine-tool and metal working. Designed to inspire and instruct apprentices. Available free to any firm.



If pipe maintenance costs are high, copper may be the solution

IF YOUR PLANT has rustable piping that's causing both trouble and expense, why not put an end to this costly nuisance by installing Anaconda Copper Tubes?

Copper tubes assembled with solder-type fittings eliminate threading. They are thus lighter in weight than standard size pipe, and cost correspondingly less per foot. In the smaller sizes they may cost little or no more than rustable piping. In addition, they offer worthwhile installation economies, and in many cases they bring important savings in space. Top off these obvious advantages with those of long, rust-free service and the free flow obtained through smooth interiors, and you are more than likely to find copper tubes the ideal solution to your general piping problems.

. . .

Anaconda Copper Tubes are available in all standara sizes and wall thicknesses. There's a wholesale distributor near you who carries both tubes and fittings in stock. 4115A

ANACONDA
from mine to consumer

Anaconda Copper Tubes

THE AMERICAN BRASS COMPANY, General Offices: WATERBURY, CONNECTICUT

Offices and Agencies in Principal Cities • In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ont.

Someone Else's Idea . . . .

THE GOVERNOR OF NORTH CAROLINA was complimenting Thomas A Edison on being a great inventor. The modest Edison looked uncomfortable and said:

"I am not a great inventor."

"But you have over a thousand patents to your credit, haven't you?"

"Yes, but about the only invention I can really claim as absolutely original is the phonograph."

"Just what do you mean?" asked the governor.

"Well," explained Edison. "I guess I'm an awfully good sponge. I absorb ideas from every source I can, and put them to practical use. Then I improve them until they become of some value. The ideas I use are mostly the ideas of people who don't develop them."

Edison had one great ability denied most of us—the ability to *see* the worth of a suggestion. Watt had it, Fulton had it, the Wright Brothers had it, Singer and McCormick had it too.

We can't all be Edisons or Watts, but we can all try. We can be alert for the casual remark or the diffident suggestions of our associates and our subordinates, for the useful idea in article, quotation, or advertisement, for the conscious or unconscious word or sentence that can start a new train of thought. The result may not be a phonograph or a steamboat, but it can be the saving of hundreds or thousands of power dollars needlessly spent.

What does it matter if the original idea belonged to somebody else? Give him due credit—and have the satisfaction of knowing that without *your* development, the idea would never have lived.

George Edwards
Engineer

IF YOU WANT TO CUT DOWN ON RE-PACKING... BETTER TRY SEA RINGS!

It's not packing— it's RE-packing that's really expensive . . . that's why it pays in dollars and cents to use the best packing money can buy. J-M Sea Rings are that kind of packing.

They're custom-made to fit specific operating conditions. Entirely automatic, they seal on the work stroke, release on the return, thus reducing friction and wear on both packing and rod. During the past 25 years many engineers have accepted Sea Rings as the standard packing for reciprocating rods and plungers operating against steam, water, air, brine, oil, gasoline and many other fluids and chemicals.

For details on J-M Sea Rings and the complete line of J-M Packings and Gaskets, write Johns-Manville, 22 E. 40th St., New York, N.Y.

JM PRODUCTS

Johns-Manville PACKINGS & GASKETS

THERE'S A DISTRIBUTOR NEAR YOU

GOLDEN-ANDERSON

Specialty VALVES

STEAM PRESSURE REDUCING

To insure a uniform terminal pressure on varying capacities, employ this superior G-A Steam Pressure Reducing Valve. It is particularly adaptable for intermittent or dead end service. Furnished in sizes ranging from 2½" to 12", it is of Double Extra Heavy cast iron, with a semi-steel, or cast steel body and bonnet. Trim consists of either bronze, monel metal or stainless steel. Efficiently handles 125 lbs. to 400 lbs. of saturated or superheated steam. Pilot control may be located remotely from the main valve. For a free copy of the latest G-A catalog . . . write today . . . it contains detailed construction and application data on the complete line of Golden-Anderson Specialty Valves.

also

Altitude Control . . . Throttle and Emergency Stop . . . Check . . . and other types of valves.

Golden-Anderson Valve Specialty Co.

Fulton Bldg. • • • Pittsburgh, Pa.

Lubrication of Air Compressors

(*Continued from page 94*)

the oil should be sufficiently fluid to flow freely when the machine is started.

With regard to pressure, the important consideration is not the maximum discharge pressure, but rather the pressure difference that exists on opposite sides of the piston. It is this pressure difference that causes blow-by. The greater this pressure difference is, the more difficult it becomes to seal the piston and maintain a film of oil on the cylinder wall.

The practice of resorting to heavier oils as the cylinder and rings wear is not to be recommended, because heavy oils cause excessive friction and carbon deposits. If wear becomes excessive, the cure is to rebore the cylinder and install new rings.

The flash and fire points of compressor oils are commonly over-emphasized. Many erroneously believe that a high flash point is indicative of high quality, low oil consumption, and freedom from fires and explosions. It is generally true, in comparing oils of the same viscosity, that the one having the highest flash point will evaporate less; hence will deposit less carbon. High oil consumption, however, is caused chiefly by the air and piston scouring the oil from the cylinder walls and its ultimate ejection in atomized form with the discharge air. The flash point bears no relation whatever to this action of the air and piston. Viscosity is the main governing factor.

Moisture in Air

Air is never dry. It always contains some moisture which is never deposited in the cylinder of single-stage compressors or in the first-stage cylinder of multi-stage machines. In 2-stage and other multi-stage compressors, moisture is deposited in the intercooler when the air is cooled below its dew-point. In these machines some moisture is still entrained in the air and is carried into the next stage. This air-moisture mixture enters the cylinder at high velocity and tends to wash the oil films from the interior surfaces. To resist this washing effect, slightly compounded oils are generally recommended for the high-pressure stages of multi-stage compressors. Compounded oils form emulsions with water and are more adhesive in the presence of water than straight mineral oils.

Fixed oils used for compounding are

THE CHAPMAN MOTOR UNIT

For Modern Power Plant Applications

Chapman Motor Unit
Yoke-Mounted on Valve Bonnet
Cover Removed Showing Simplicity
and Small Number of Parts

OUTSTANDING FEATURES

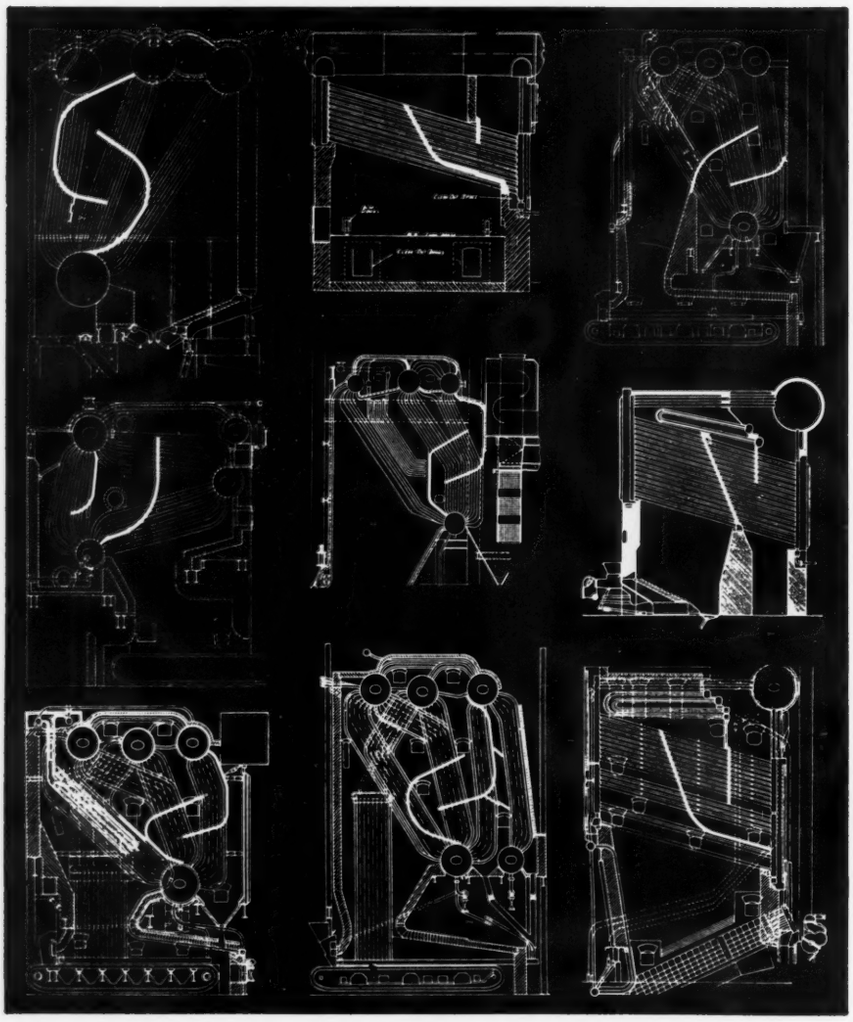
- Rugged Construction
- Simplicity
- Small Number of Parts
- Hand Wheel Safety
- Protection from Obstruction
- Use in any Position
- No Drift
- Slow Speed High Torque Motor
- Predetermined Seating
- No Jamming
- Push Button Control, Remote or at the Unit.

THE OUTSTANDING UNIT FOR MOTORIZED VALVE CONTROL

Positive, dependable operation and proper seating are essential to successful motor operation of power plant valves. "Jamming" is the "bugaboo" of high pressure valve control. All possibility of jamming, regardless of pressure or temperature, has been eliminated in the Chapman Motor Unit. This and other exclusive Chapman features are responsible for its wide use and superior performance in the power field.

THE CHAPMAN VALVE
MANUFACTURING COMPANY
INDIAN ORCHARD, MASS.

Enco Streamline Baffles



YOU CAN INCREASE CAPACITY AND EFFICIENCY IN EXISTING OR NEW BOILERS

Installation of ENCO Baffle Walls in all types of water tube boilers has resulted in immediate improvement in performance, operation and maintenance.

Better heat distribution, maximum heat transfer to boiler and superheater surfaces, lower draft loss, lower flue gas temperatures and higher capacity are assured through ENCO design and construction. In addition, the smoothly curved surfaces of ENCO streamlined baffles tend to prevent fly ash and cinder accumulation, saving time and steam by making it easier for soot blowers to do a more thorough and efficient job of keeping heating surfaces clean.

ENCO Baffles, constructed gas tight with Enco Plastic, Tile and Reinforcement provide for expansion and assure extra strength. They may be built in desired locations assuring minimum disturbance when tube renewals are required.

Flexible design, the careful selection of materials and their installation by experienced mechanics result in a construction which can be depended on for long service under severe operating conditions.

TAKE ADVANTAGE OF **ENCO SERVICE** TO IMPROVE YOUR BOILERS

Send blue prints and operating data and ask ENCO engineers to submit suggestions. No obligation, of course. Ask for the new Enco bulletin BW 40—sent FREE on request and containing detailed engineering information on modern ENCO Baffle Walls for all types of water tube boilers. Write for your copy TODAY.

ENCO PATENTED BAFFLES FURNISHED EXCLUSIVELY BY

THE ENGINEER COMPANY

75 West St., New York, N. Y.

more easily oxidized than straight mineral oils. Therefore, the percentage of compound should be just sufficient to counteract the moisture and no more. Usually one percent of compound is sufficient.

Carbon-residue number is of some value in selecting compressor oils, but it is not the sole factor in determining the probable amount of carbon formed in an air-compressor cylinder. Concentration of impurities in the air, operating temperature, and viscosity of the oil at the operating temperature are also important.

Mineral Oils

Mineral oils are composed of many different hydrocarbons, each having a specific boiling-point. Low-boiling hydrocarbons vaporize first, leaving the high-boiling ones as residue. These high-boiling hydrocarbons, being in intimate contact with hot air, are prone to oxidize or decompose to form a sticky, tarry material that acts as a binder for the impurities from the air and worn bits of metal from the compressor cylinder.

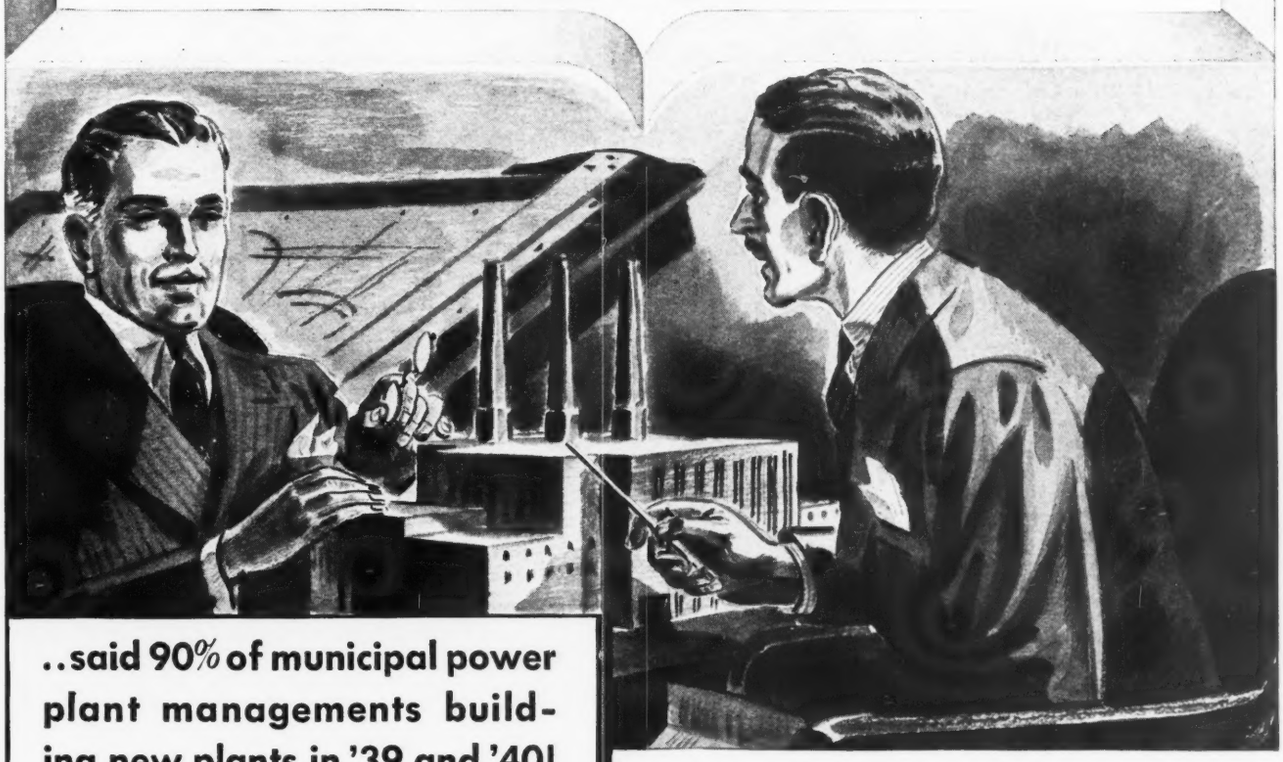
This mass of air impurities, oxidized oil, and some pure carbon, bakes under continued high cylinder temperatures into a more or less hard deposit. In general, the real carbon is less than 25% of the total mass. The real carbon, with but few exceptions, depends on the character of the oil. Other factors being equal, the higher the viscosity of an oil and carbon-residue number, the greater its tendency to form carbon deposits. Likewise, paraffin-base oils, because of their higher carbon-residue number, tend to deposit more carbon on the compressor parts than oils of other bases.

Carbon Deposits

The real carbon of the so-called carbon deposits depends on the "make-up" of the oil, as well as on the amount fed to the cylinder. If a blended oil, consisting of cylinder stock and a comparatively light-bodied distillate, is used, the tendency is for the distillate to vaporize, leaving the heavy cylinder stock as a residue to oxidize and act as a binding agent for air and other impurities. Such an oil may have the correct viscosity but its flash-point would be low and not consistent with its viscosity.

It is common practice to use motor oils for lubricating many of the small portable compressors. Most motor oils are blends of distillates and bright stock, which is a refined cylinder stock. For the reason stated above, motor oils are not generally considered to be good compressor oils.

"WHEN WE BUILD..WE'LL BUILD FOR MODERN COAL"



..said 90% of municipal power plant managements building new plants in '39 and '40!

OF THE NEW municipal power plants built during the past two years to operate on a single type of fuel, COAL was chosen by a margin of *nine to one!*

For cities or private industries, large or small, the source of power must be *dependable*. Shut-downs are costly at any time, but in a nation geared to a huge defense job they're doubly serious. Industry knows it can rely on modern prepared coal for the steady production of steam power and a quick response to extra load demands. Furthermore, utility and industrial figures underscore the *economy* of modern coal—in terms of lower cost per pound of steam, higher plant efficiency and lower maintenance costs.

WHAT'S YOUR POWER PROBLEM?

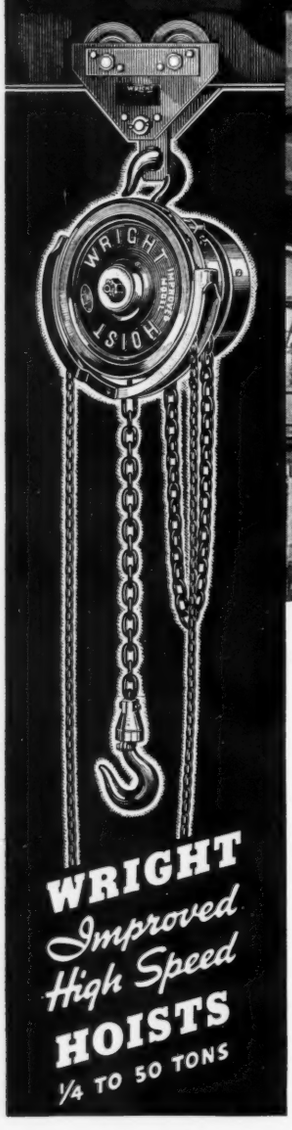
In many power plants the free assistance of Chesapeake and Ohio Fuel Service Engineers has proved invaluable. If you have a problem involving fuel costs and efficiencies, these highly skilled men may find the answer for you. Why not let them study your present set-up, confer with your engineers and make suggestions? You have everything to gain—without cost or obligation. If you'd like us to send one of our engineers, write GEORGE H. REINBRECHT, Coal Traffic Manager, Chesapeake and Ohio Lines, 2901 Terminal Tower, Cleveland, Ohio.

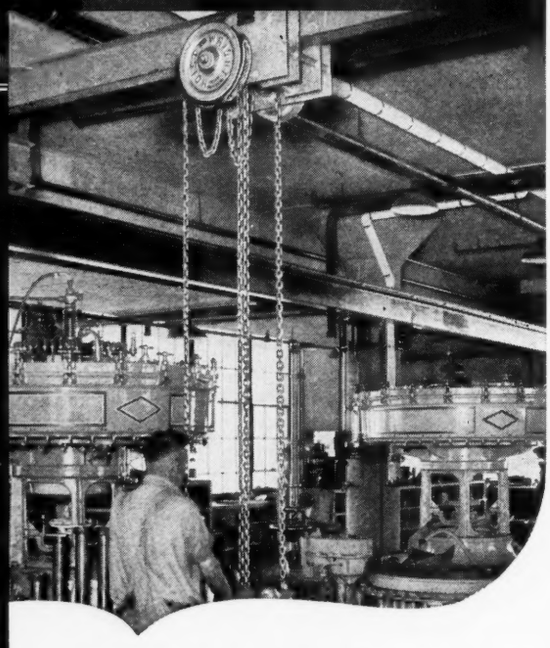
IT PAY$ TO U$E MODERN...

Chesapeake and Ohio Lines

ADVERTISING PAGES REMOVED

THE WRIGHT WAY TO SPEED PRODUCTION





● *FASTER, ever faster* production is demanded of American industry. One tool that will help speed up your production is the Wright Improved High Speed Hoist.

Wright Hoists are engineered for *fast*, high speed work. Their action is smooth and positive — because of their correct load wheel and driving spindle bearings. They are also *safe* and *economical*.

Ruggedly constructed on precision design, Wright Hoists give you long-time trouble-free service. The full zinc coating makes Wright Hoists especially adaptable when corrosive atmospheres exist.

As with all ACCO products, safety is an in-built feature. The load chain has a safety factor of 7 to 1. It is made of a special process steel which permits the chain to elongate (under overload) 3″ to the foot before breaking. This same visual factor of safety is inherent in the bottom hook which will slowly open to indicate overload beyond the elastic limit of the chain.

WRIGHT TROLLEYS are made to give the same *fast, economical, safe* service as WRIGHT HOISTS. Write for your copy of the new Wright Catalog and learn the 21 points of WRIGHT superiority.

WRIGHT MANUFACTURING DIVISION
YORK, PENNSYLVANIA

TRADE MARK ACCO

AMERICAN CHAIN & CABLE COMPANY, Inc.
In Business for Your Safety

Turbine Governing

(*Continued from page 118*)

A few governors are operating today which are entirely inadequate for the duties required of them. These governors can be modified or rebuilt to meet required standards if and when the expense is justified. In some cases, as long as the governor protects the turbine-generator, it has not been deemed advisable to expend the funds required to accomplish the niceties of speed regulation.

It is not believed that there are any major deficiencies in governing systems. A few systems have recently experienced some large industrial loads, which have made the existing governing system seem inadequate. Other systems have experienced difficulties in tie-line interchanges and the correlation of steam and hydro governors. These problems require much thought and effort for their solution, but this is gradually being accomplished.

Frequency Control

A few years ago, much reliance was placed upon the use of automatic frequency control, and no doubt the interest in this type of equipment has caused some relaxation of attention to speed governors. Lately, many operators are returning to the thought that speed governors are the fundamental speed-regulating equipment, and that automatic frequency control is only a vernier control. It is obvious that very few of the automatic frequency-control installations are able to cope with any sudden or large load changes without assistance both from the governors and the operators.

General conclusions reached were:

1. There are no outstanding deficiencies in modern governing systems.

2. It seems that the inherent capabilities of many governors are not being fully utilized.

3. Full possibilities of governors often are not used until a fluctuating load or unusual incident arises that requires making use of them.

4. A test program is required to disclose maintenance defects, wrong adjustments, and improper operation.

5. Limitations of the speed governor for interconnected operation must be recognized, and means provided to supplement the governor when close control of frequency or tie-line load is required.

"DRY CLEANED"

COMPRESSED AIR
from a
W-K-M MASTER SCRUBBER
Will not Stain or Moisten a Snow White Handkerchief*

(NO ATTENTION OR MAINTENANCE)
NO MOVING PARTS

ACTUAL TEST

With a continuous trickle of dirty, oily water running from the drain, a 1" W-K-M "MASTER" Scrubber, wide open to atmosphere on 100# air pressure, delivered "dry cleaned" air by the above test.

***COMPARABLE QUALITY OBTAINED ON GAS AND STEAM**

BRADSHAW & CO., 530 Fourth Ave., Pittsburgh, Pa.

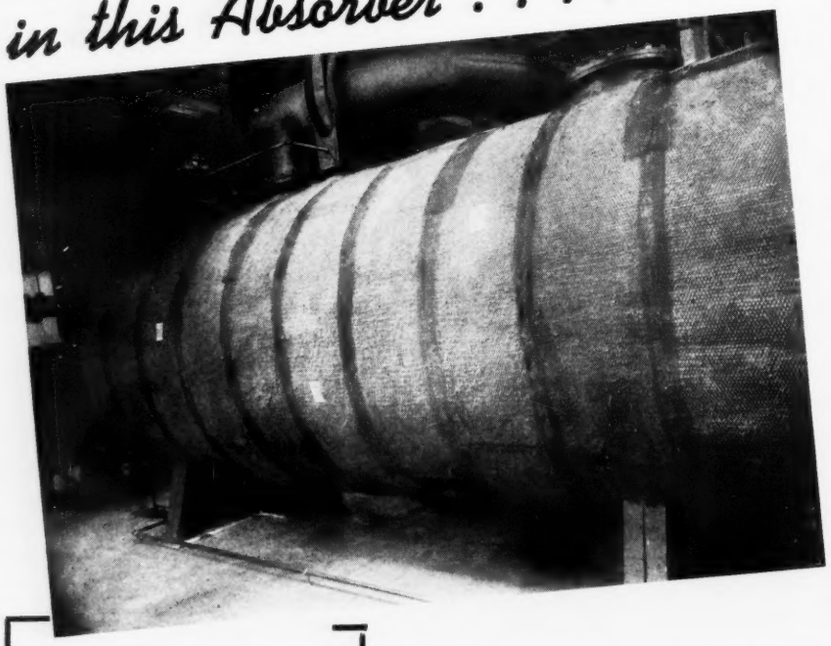
Gentlemen: Without obligation, you may send me the bulletin fully describing the W-K-M Master Scrubber for: GAS / AIR / STEAM

Name / Company / Address / City / State

(PLEASE PRINT)

B-H BALDWIN-HILL BLANKETS

Maintain Uniform Temperature in this Absorber . . . . . .



ABSORBER shown above is used on a SOLVENT RECOVERY SYSTEM and INSULATED with BALDWIN-HILL Black Rockwool BLANKETS

FOR MAXIMUM EFFICIENCY of this process, a temperature of 350°F. inside the tank must be maintained—and is accomplished through the application of B-H Black Rockwool Blankets, 2" thick.

In fact, B-H Blankets are highly effective in minimizing heat losses on equipment heated to 1200°F. With their soft edges butting together to form a continuous blanket of insulation, there are no cracks or joints to permit the escape of heat.

The chemical stability of B-H Black Rockwool also gives it high resistance to moisture. Neither dampness nor heat can cause structural disintegration of the fibres to cause settling and loss of efficiency. On any problem of insulation call in a B-H engineer.

SEND FOR CATALOG

for complete data on entire line showing heat loss charts, insulating efficiencies, etc. of B-H Black Rockwool Blankets . . . B-H Mono-Block . . . B-H No. 1 Insulating Cement . . . B-H Weatherseal . . . B-H Bond-Tite . . . B-H No. 100 Pipe Covering and other insulating materials effective up to 2000°F.

BALDWIN-HILL CO.
575 Klagg Ave., Trenton, N. J.
New York—Boston—Chicago—Kalamazoo, Mich.

Reduce Heat Losses with **BALDWIN-HILL** B-H *High Efficiency* **INSULATIONS**

Argument Corner

(Continued from page 113)

became a local fire engine authority, being written to and sent for when emergencies arose.

Now, a steam fire engine never breaks down or even "witches" except at a fire; and the bigger the fire and the more combustible or valuable the property attacked, the more the engine is pushed and the greater the chance of something wrong happening, just at a time when little or nothing can be done to help out.

On one occasion, when there was a mighty blaze and the boiler was pushed to capacity plus, the main bearing "froze", and of course the engine (Scotch yoke type) was brought to a standstill.

Nothing to do but to uncouple and leave the blaze to the other volunteer companies. But the bearing, utterly ruined, must be replaced. Manchester being far off, getting a pattern and a casting made, machined and adjusted, would take time; and we (by that time I could say "we") had no time.

So I proposed an emergency bearing, that could be made, applied, and used until a bearing could be obtained from the shop, 'way up in New Hampshire.

We made an emergency block of good apple wood, boiled it in oil, got it in fine shape and fit just before a fire broke out and the engine was put in service. The intention was to trust to luck and apple wood, until the bronze spare arrived.

But the fun of it was that the machine was even cooler with the emergency block than formerly with the bronze. As luck would have it, it was nearly two years before it was found necessary to scrap the apple-wood and insert the bronze bearing.

All of which shows just what you choose to make of it. For my part, I got a new feather in my cap, not due to any fraternal relationship. (He was only my half-brother, anyhow, and a doctor at that.)

Leonia, N. J. ROBERT GRIMSHAW

INDEX TO ASTM STANDARDS, INCLUDING TENTATIVE STANDARDS *(1940). Issued by American Society for Testing Materials, 260 S Broad St, Philadelphia, Pa. No price listed.*—Contains the index to ASTM standards and tentative standards, listing in numerical sequence of ASTM serial designations, officers of the society, list of committees, ASTM standards, publications and prices, and membership application.

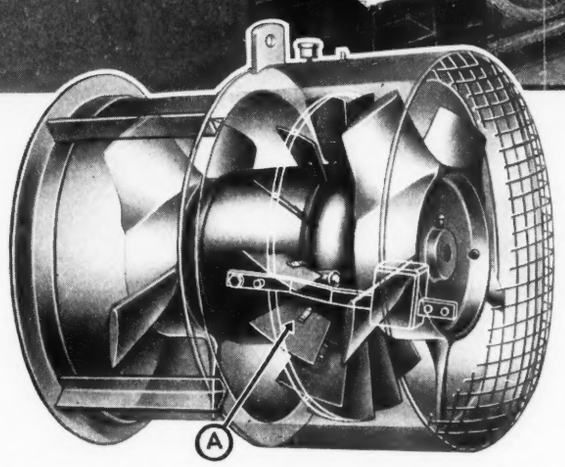
The World's Largest College for Women – HUNTER COLLEGE Installs WING Latest Type COM Blowers

Architects: Shreve, Lamb & Harmon

Harrison & Foulhoux, Associated Architects

By the use of WING Blowers the forced draft equipment becomes a part of the boiler front . . .

4 WING Type COM Blowers at Hunter College. Note neat, compact mounting on windbox; *all duct work completely eliminated.*



Phantom view of WING Blower, showing double-staged axial flow fans, and built-in, adjustable damper vanes (A) which assure precise regulation of air delivery with decreasing horsepower over a wide range. Capacities to 50,000 cu. ft./min.; static pressures to 10".

Hunter College's new 16-story skyscraper represents the latest engineering and architectural design in urban colleges. It is replete with heating, ventilating and air conditioning equipment of advanced design.

The proper functioning of these systems to care for faculty and day students numbering nearly 6,000 is dependent upon the power generated in the boiler room. Here 4 WING Type COM Axial Flow Blowers supply the forced draft for B & W Boilers fired by Todd Oil Burners.

This is another outstanding installation of WING Type COM Blowers, known for their high efficiency, unexcelled dependability and quiet operation.

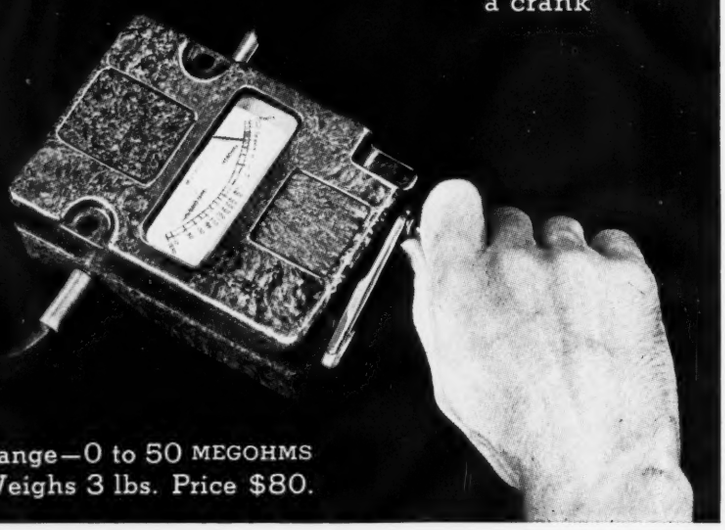
Write for Bulletin CO-3.

L. J. WING MFG. CO. *Specialists in Air Handling Equipment for Over 40 Years* **W. 14th St. & 7th Ave., New York City**

WING TURBINE & MOTOR-DRIVEN BLOWERS . . . TURBINES EXHAUSTERS . UNIT HEATERS

MIDGET
"MEGGER"
TRADE MARK REGISTERED U.S. PAT. OFF.
INSULATION TESTER

500 VOLTS D. C.
Simply by turning
a crank



Range—0 to 50 MEGOHMS
Weighs 3 lbs. Price $80.

Protection Against Electrical Breakdowns

Here is a testing device that should be used today by every maintenance man who is seriously interested in forestalling electrical failures. Detects dirt, moisture and deterioration in the insulation of practically all types of electrical equipment. No batteries or any "adjustments." Independent of all external current. Simply turn the crank; read the scale. Can be carried in pocket or tool kit and is ready for use *any time* and *any where*.

"Meg" Insulation Tester
"Megger" instruments of this type have ranges up to 2000 megohms with hand generators up to 1000 volts.

Our Midget "Megger" Tester as well as other types of hand-driven and motor-driven "Megger" Insulation Testing Instruments is described in new Catalog 1685-P just issued. Write for copy.

James G. Biddle Co.
1211-13 ARCH STREET *Electrical and Scientific Instruments* PHILADELPHIA, PA.

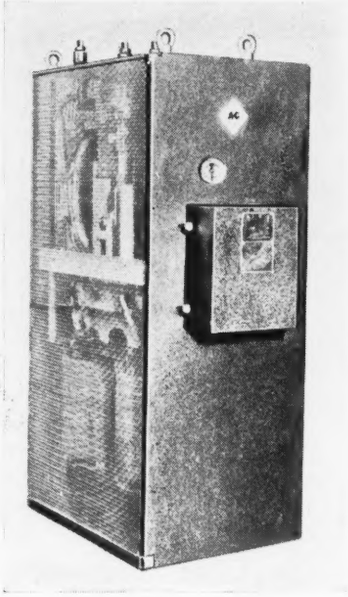
New Plant Equipment

(Continued from page 132)

whether equipment runs true, functions efficiently, carries load properly and for calibrating. Mechanism to be tested can be placed in position on horizontally-adjustable mounting bracket, moved up as required and then connected to variable-speed output shaft of PIV transmission. Electric tachometer and calibrated speed indicator, positively-driven from variable-speed shaft, provide means for observing exact speed at which mechanism is being tested. *Link-Belt Co, 307 N Michigan Ave, Chicago, Ill.*

Air-Cooled Regulator

DRY-TYPE AIR-COOLED REGULATOR for feeder-voltage regulation available in ratings of 36 kva to 96 kva, 2400 volts, single-phase. Regulator is step-type, having 32 ⅝% steps to provide plus or minus 10% regulation. Transformer is air cooled without blowers

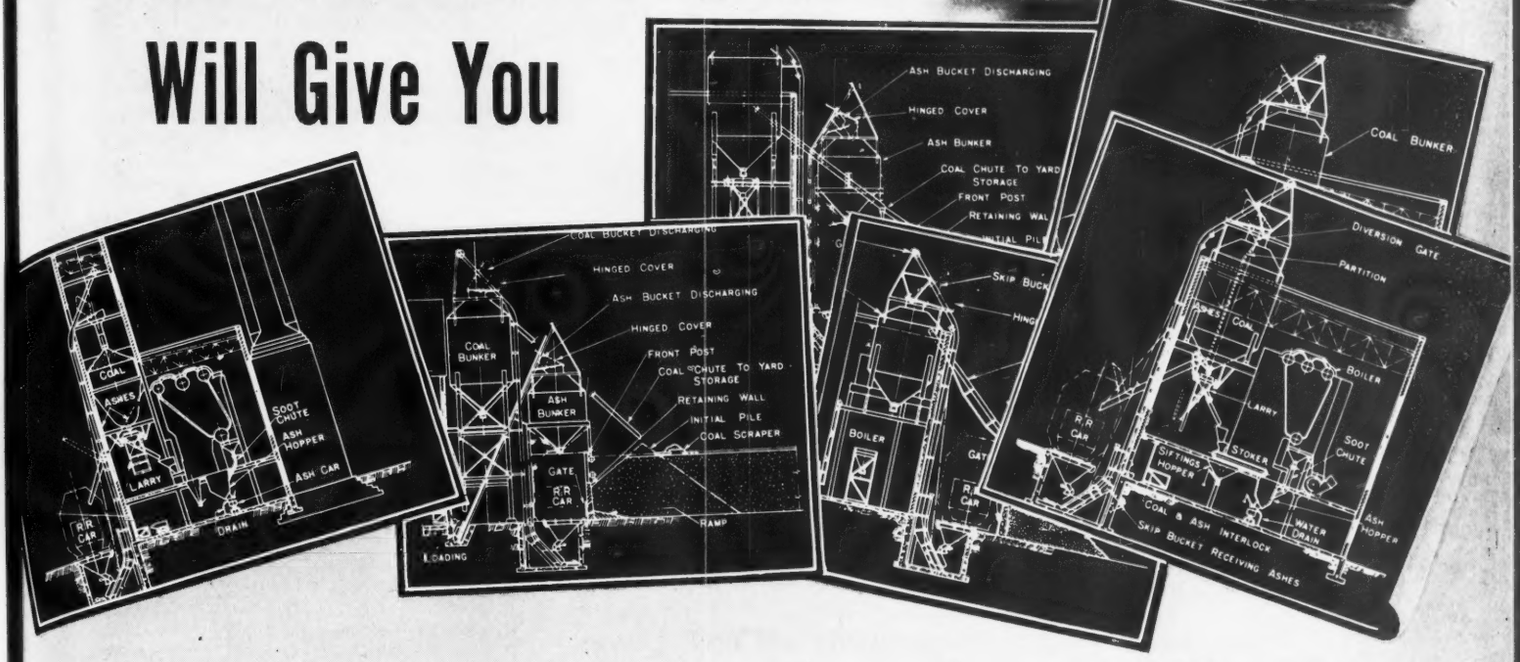


or forced ventilation, and tap-charger operates in air without lubrication. Elimination of oil coolers makes fire-proof vaults unnecessary and does away with periodic maintenance and oil filtering. Dry operation permits easy inspection, as single door makes all working parts accessible. *Allis-Chalmers Mfg Co, Milwaukee, Wis.*

Voltage Regulator

INDIRECT-ACTING RHEOSTATIC GENERATOR-VOLTAGE REGULATOR is for automatic voltage-control of medium and large size ac generators in central stations or large municipal and industrial plants, and for synchronous motors and condensers. Operational feature is its high-speed action time of 3 cycles after a voltage change. This, and its ability to force exciter field to its limit quickly, makes it suitable for

In 9 out of 10 cases a BARTLETT-SNOW Standard Coal Handling System Will Give You



More Equipment for Less Money

● Engineers recognize today that one or another of the Bartlett-Snow Standard Coal Handling Systems meets exactly the requirements of 90% of boiler plants rated from 1000 to 5000 H. P. Each system consists of track or other receiving hopper, a skip hoist, bunker, weigh larry, and even field storage and ash handling if desired . . . is adapted for installation in existing or new buildings, and can be altered to meet a variety of yard and track conditions. Each represents an actual installation of proven fitness for that size and type of plant, and since they incorporate the use of standard units, they minimize the charges for new enginering—and permit the maximum amount of the appropriation to be expended for actual machinery and plant facilities.

Bartlett-Snow's Coal Handling Systems are being used by consulting and company engineers alike in some of the best known concerns in the country. They have proven their efficiency. Complete details, including engineering diagrams, illustrations, etc., have been reproduced in a 48-page bulletin which will be sent on request to responsible engineers or company officials. It's free. Write for a copy of Bulletin No. 83 today.

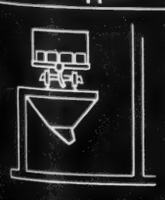
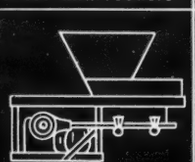
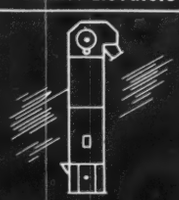
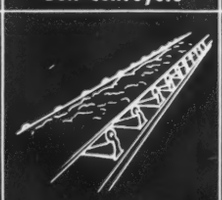
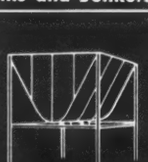
THE C. O. BARTLETT & SNOW COMPANY

New York • Chicago • **CLEVELAND, OHIO** • Baltimore • Des Moines

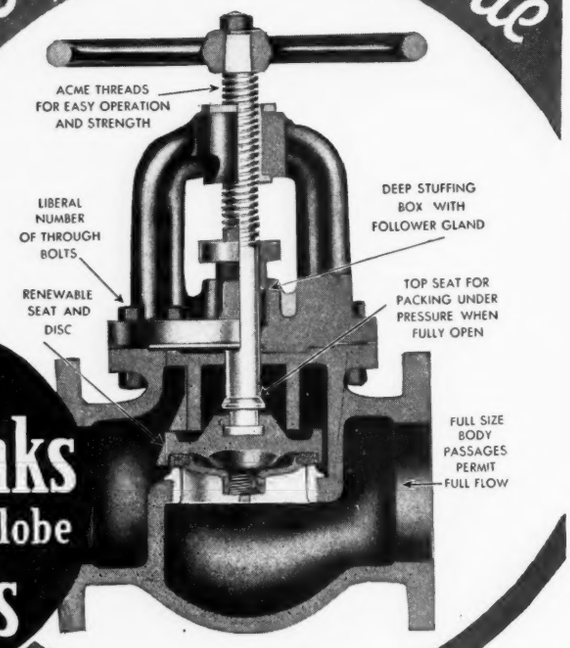
BARTLETT-SNOW

• • BOILER PLANT COAL HANDLING SYSTEMS • •

Complete Engineering and Fabricating Facilities to Meet Any Requirement Including

Track Hoppers	Gates and Feeders	Skip Hoists	Bucket Elevators	Belt Conveyors	Bins and Bunkers	Weigh Larries
						

America's Biggest Valve Value


ACME THREADS FOR EASY OPERATION AND STRENGTH
LIBERAL NUMBER OF THROUGH BOLTS
RENEWABLE SEAT AND DISC
DEEP STUFFING BOX WITH FOLLOWER GLAND
TOP SEAT FOR PACKING UNDER PRESSURE WHEN FULLY OPEN
FULL SIZE BODY PASSAGES PERMIT FULL FLOW

Fairbanks Iron Body Globe Valves

Where else will your valve dollars buy such outstanding value as in this Fairbanks Iron Body Globe Valve?

Where else will you get valves made of a semi-steel of a tensile srength 66⅔% greater than ordinary cast iron . . . that have a seat and disc which can be renewed in a few minutes right on the pipe line . . . with back seating on spindle to permit repacking under pressure . . . with strong deep-cut threads . . . with guides in body to insure perfect seating of discs . . . bushed throughout to insure long, dependable service.

Only when you try one of these Fairbanks Valves will you believe that any valve could operate so easily, close so tightly and cost so little for maintenance.

Get a "close-up" of the biggest valve value by asking your Fairbanks distributor to compare this valve, part for part, with any other.

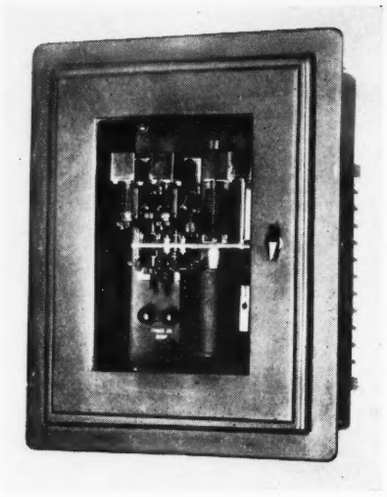
Write now for catalog No. 21.

THE FAIRBANKS COMPANY

397 LAFAYETTE ST., NEW YORK, N. Y.

Valves, Dart Unions, Hand Trucks and Wheelbarrows

Boston, Mass., Pittsburgh, Pa.
Distributors in Principal Cities
Factories: Binghamton, N. Y., Rome, Ga.



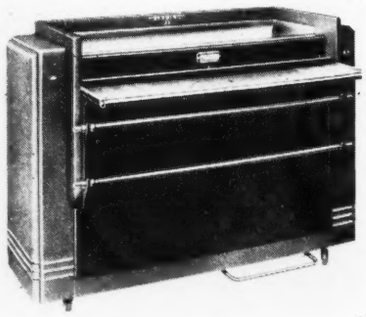
quick response systems. Regulator-element responds to average 3-phase voltage, hence will not operate falsely on an unbalanced system fault. Construction features include an anti-hunting action to correct for normal voltage deviations. Built-in adjustment provides means for adjusting regulator characteristics to match those of generating equipment. *Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*

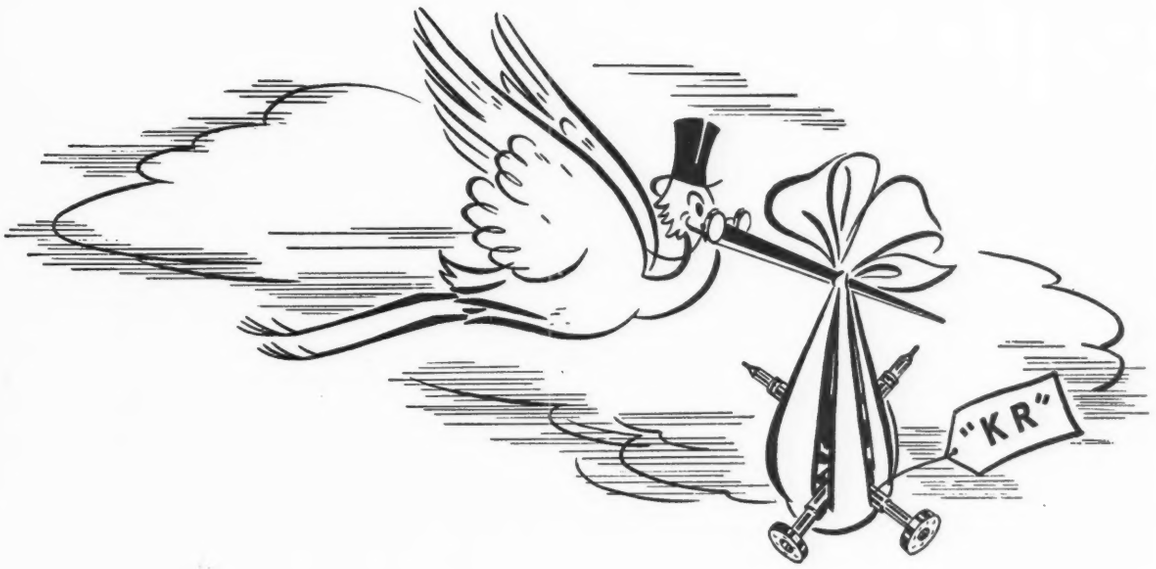
Temperature Regulator

VAPOR LINE CONTROL is designed to control heating medium on degreasers. Feature is sensitive bulb or thermostat, formed of heavy-wall helically corrugated tubing, braced inside. It exposes large surface to vapor, in relation to its content, which results in a rapid response to temperature changes. Temperature adjustment is made by sliding bulb up or down in brackets until a position is found for vapor line in tank, which maintains correct temperature. Available in sizes from ½ to 2 in., for temperatures up to 400 F. *Sarco Co, Inc, 183 Madison Ave, New York, N. Y.*

Printing Machine

MODEL 55, 42-in. printer, operates with either cut sheets or roll stock. It prints ink tracings at from 12 to 15 fpm. Entire top of machine serves as print-return tray, and return is so designed that tracing enters tray on top of print, eliminating necessity for reversing tracing when reinserting it into machine. Light source is





Announcing...

...an important addition to the family of Inco high-Nickel alloys

*"KR" MONEL

Combined in this new alloy are *four* important characteristics now available in *one* metal. In addition to being strong and highly resistant to corrosion, "KR" MONEL is...

FREE-MACHINING and HARDENABLE BY HEAT TREATMENT

Available in the form of rod and wire, "KR" MONEL is suitable for production of corrosion resisting parts that can be heat-treated after machining to develop extra strength and hardness for tough jobs. "KR" MONEL is a non-magnetic alloy. Note properties of "KR" MONEL in table below. Write for more complete information. Address:

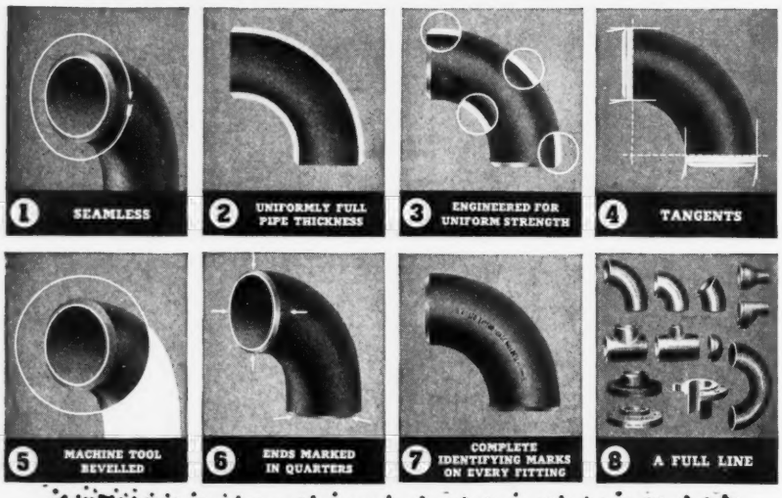
THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N.Y.

PROPERTIES OF "KR" MONEL

	Yield Strength 1000 psi	Tensile Strength 1000 psi	Elong. — % in 2"	Hardness BHN 3000 Kg.
Hot rolled	40-85	90-120	45-30	140-225
Hot rolled, age hardened	90-120	135-160	30-20	260-300
Cold drawn	70-100	100-125	35-15	175-250
Cold drawn, age hardened	100-130	140-170	30-15	260-320

**Trade-mark of The International Nickel Company, Inc.*

Why be satisfied with "just-as-good" welding fittings? WeldELLS alone offer you all these 8 aids to faster, easier pipe welding.


1 SEAMLESS
2 UNIFORMLY FULL PIPE THICKNESS
3 ENGINEERED FOR UNIFORM STRENGTH
4 TANGENTS
5 MACHINE TOOL BEVELLED
6 ENDS MARKED IN QUARTERS
7 COMPLETE IDENTIFYING MARKS ON EVERY FITTING
8 A FULL LINE

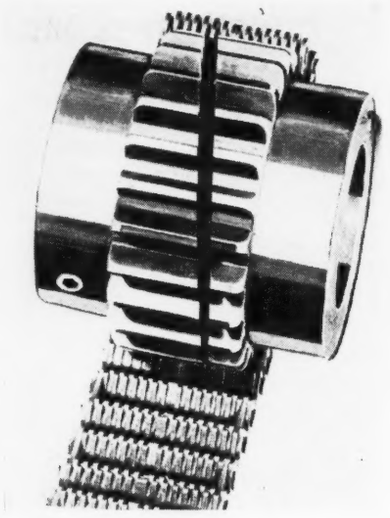
TAYLOR FORGE
WeldELLS
Seamless Pipe Fittings for Welding

TAYLOR FORGE & PIPE WORKS
General Offices and Works: Chicago, P. O. Box 485
New York Office: 50 Church St.
Philadelphia Office: Broad Street Station Bldg.

55-watt mercury vapor quartz lamp, guaranteed for 1,000 hours. Lamp is installed in revolving 9-in. Pyrex contact cylinder, which provides almost perfect contact. *Charles Bruning Co, Inc, 100 Reade St, New York, N. Y.*

Chain Coupling

TYPE D RAMSEY FLEXIBLE-CHAIN COUPLING is constructed to eliminate completely shearing of pins in chain, a condition frequently found in both roller and silent chain-type couplings. New pinions, instead of having straight sides, are cut diagonally



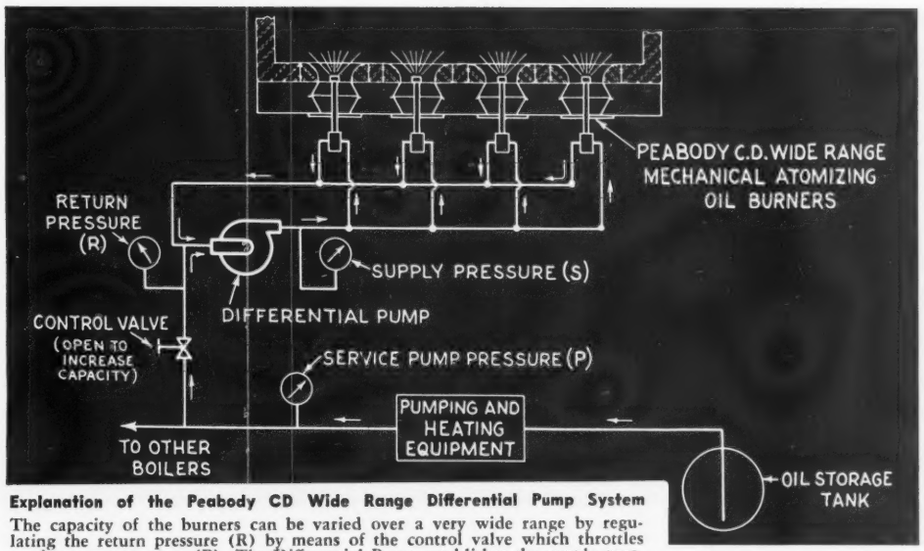
so that one pinion pulls other through chain, employing full tensional strength of chain's width, and resulting in same characteristics of an ordinary chain drive. Wear of teeth, due to excessive misalignment, is distributed evenly across entire face of both pinions. *Ramsey Chain Co, Albany, N. Y.*

Electric Drill

"BLUE-POINT" DRILL built to meet need for lighter and more compact drill for constant production or repair service. Pistol grip centered below body and weight of tool is centered across hand to provide comfort for operator. Ball-bearings are used on armature

PARKCHESTER Installs 16 PEABODY CD "Wide Range" Oil Burners

Using the PEABODY DIFFERENTIAL PUMP SYSTEM →


PEABODY C.D. WIDE RANGE MECHANICAL ATOMIZING OIL BURNERS
RETURN PRESSURE (R)
SUPPLY PRESSURE (S)
DIFFERENTIAL PUMP
CONTROL VALVE (OPEN TO INCREASE CAPACITY)
SERVICE PUMP PRESSURE (P)
PUMPING AND HEATING EQUIPMENT
TO OTHER BOILERS
OIL STORAGE TANK

Explanation of the Peabody CD Wide Range Differential Pump System

The capacity of the burners can be varied over a very wide range by regulating the return pressure (R) by means of the control valve which throttles service pump pressure (P). The Differential Pump establishes the supply pressure (S) which is always a constant amount higher than return pressure (R).

PARKCHESTER—the world's largest residential project—built in New York City's Bronx Borough by the Metropolitan Life Insurance Company, will be the home of 12,200 families, approximately 42,000 persons. It covers 129 acres, has 51 apartment buildings, garage space for 4,500 cars, theatre, shopping and office center—and a LARGE MODERN POWER PLANT.

Four boilers, each with a capacity of 135,000 pounds of steam per hour, are equipped with a total of 16 Peabody Constant Differential Wide Range Burners and the Peabody Patented Differential Pump System. This system is the most recent and important development in efficient oil firing.

THESE ARE SOME OF ITS ADVANTAGES:

- EXTREMELY WIDE RANGE IN CAPACITY from near zero boiler output to full load, without changing tips, cutting out burners, or manual adjustment of burners.
- IMPROVED ATOMIZATION as made possible by the Differential Pump which steps up the oil pressure, provides a constant differential across the tangential slots and a constant atomizing power at all loads.
- NO HOT OIL RETURN. No oil goes back from the boiler to the suction of the service pump or to the tank. Only the oil actually burned is pumped to the boiler.
- EASE OF CONTROL. All burners on each boiler are controlled automatically by the Combustion Control System which opens a valve to increase, or closes to decrease the capacity of the burners. The quantity of oil fired is a straight line function of the oil pressure at the inlet to the Differential Pump. Oil consumption can be readily "metered" as delivery line is always under positive pressure and there is no return oil.

PEABODY ENGINEERING CORPORATION

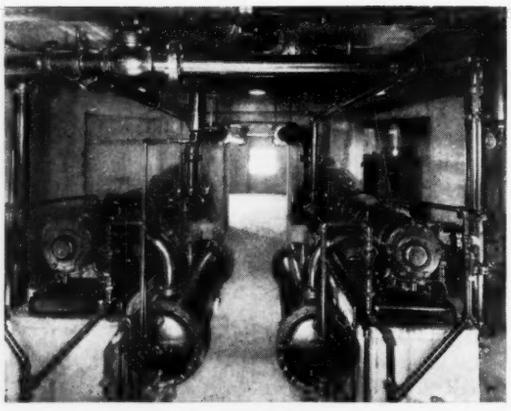
580 FIFTH AVENUE • NEW YORK

BEACON (N. Y.) BOSTON CHICAGO CLEVELAND DENVER
DETROIT EAGLE PASS (TEX.) HOUSTON HONOLULU
KANSAS CITY LOS ANGELES MEXICO CITY MINNEAPOLIS
MONTREAL NEW ORLEANS PHILADELPHIA PITTSBURGH
PORTLAND (ORE.) ST. LOUIS SAN FRANCISCO SEATTLE TULSA

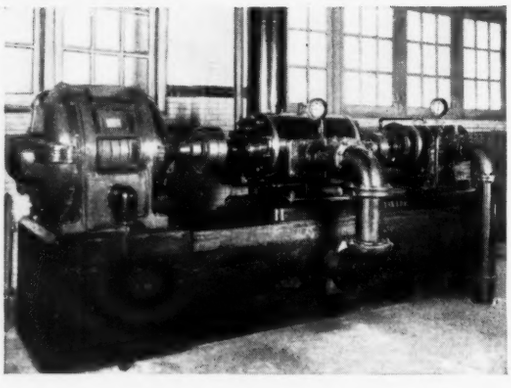
PEABODY LIMITED, LONDON

FULLER ROTARY COMPRESSORS *for* 100-LB. PRESSURE

Based on facts . . . Proof that Fullers are 80 to 125-lb. service units.



750 C.F.M. each, actual free-air delivery, **100-lb. pressure** Two-stage Rotary Compressors, installed early 1935 in a cement plant in Pennsylvania. This plant is equipped exclusively with Fuller Rotaries, a total of seven installed. All of these machines have fine performance records with low maintenance costs. During six years of operation the company has spent only $383.89 for repairs, an average of $9.14 per machine, per year. This record speaks for itself.



1000 C.F.M. actual free-air delivery, **100-lb. pressure,** Two-stage Rotary Compressor, installed April, 1934, in a food products plant in Illinois.

Write for Bulletin C-3A

FULLER COMPANY
CATASAUQUA, PENNSYLVANIA

Chicago: 1118 Marquette Bldg.
San Francisco: 320-321 Chancery Bldg.

C-51

Fuller

FULLER-KINYON, FLUXO, AND AIRVEYOR CONVEYING SYSTEMS
ROTARY AIR COMPRESSORS AND VACUUM PUMPS
ROTARY FEEDERS AND DISCHARGE GATES
AIR-QUENCHING COOLERS · · · · BIN SIGNALS

shaft and chuck spindle and needle roller bearings are on gear shafts. Universal-type motor operates on ac or dc up to 60 cycles, and is cooled by balanced fan mounted on armature shaft. No-load speed is 450 rpm, while full-load speed is 300 rpm. *Snap-On Tools Corp, Kenosha, Wis.*

Extension Light

SAFEGUARD PORTABLE LAMP GUARD has rubber handle, to which is attached a metal cage by means of a rubber locking ring. A "Water-Seeled" socket is placed within handle, and rubber shoulder projects from top edge of rubber handle. This holds socket so that it cannot slide or come out of handle at any time. In lighting cable assembly, joints are first made firm, then soldered and rubber-taped. Joint is

now waterproof. Excess tape extending over cord forms a wedge. This wedge fits in slot of handle on lamp, when pulled through the handle by cord. Harder the pull, the tighter it binds in slot, eliminating any possible strain in joints or on socket terminals, which are vulcanized into rubber socket. When it becomes necessary to replace lamp, all that is necessary to do is snap rubber ring back, insert new lamp and re-snap ring into place again. *Safeguard Electric Co, 1 De Kalb Ave, Brooklyn, N. Y.*

High-Level Lamp Fixtures

OPEN-END twin lamp luminaire for fluorescent lamps is designed especially for high-level illumination in industrial plants, and utilizes 100-watt, 60-in. white or daylight fluorescent lamps. Units consist of a hood, reflector, lamp holders, starting device, and ballast equipment. Two reflector

SHAW

for DEPENDABLE

PIPING

PREFABRICATION & INSTALLATION

*B*enjamin F. Shaw Company's long-experienced, specially trained personnel, modern plant and equipment facilities enable this company to insure its customers the utmost in precision and service in the fabrication and installation of all types of piping work.

BENJAMIN F. SHAW CO.

SERVING INDUSTRY SINCE 1891

PIPING FABRICATORS & CONTRACTORS

WILMINGTON, DELAWARE

EUREKA PACKINGS

FLAX — ASBESTOS
RUBBER — METALLIC

AMBEST—the Universal Packing

available for all pressures and temperatures up to 550° F.

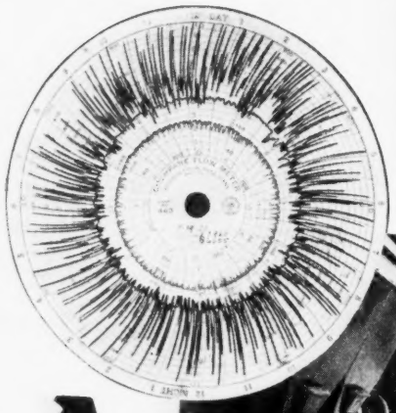
Good till the last stroke on any good rod—universal for reciprocating or centrifugal rods. Try "AMBEST" on your engines, pumps, compressors, throttles, steam valves, condensers and any other applications where you want the utmost in packing protection, ease of application and low packing cost.

SEND FOR THE 36-PAGE EUREKA CATALOG

Select the packing you need—and TRY IT. Results will convince you that "EUREKA" is the packing for you.

PATENTED "EUREKA" TRADE MARK

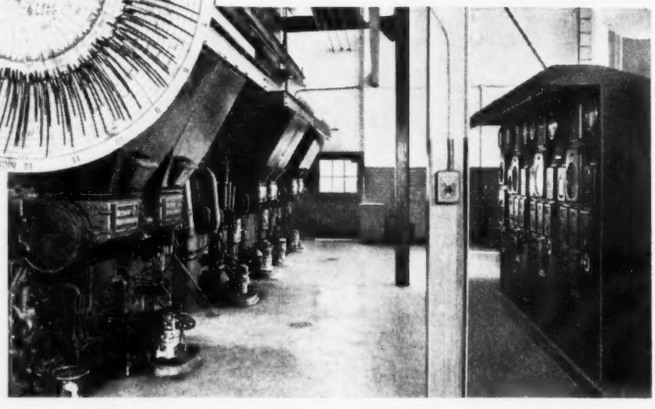
EUREKA PACKING CO., 294-296 46th St., BROOKLYN, N. Y.



Flow meter chart above shows abrupt load swings—note how the steam pressure remains close to 125 lbs.

HANDLES *automatically* LOAD SWINGS OF FROM 8,000 to 25,000 lbs. OF STEAM PER HOUR...

For Rubber Goods Manufacturer



THIS Company manufactures extruded and molded rubber products such as automobile floor mats, steam is used chiefly in curing vats, vulcanizers, molding machines and for space heating. Steam is introduced intermittently to the curing vats, consequently the process load is extremely variable as shown by the chart. *Six to ten times an hour the load jumps abruptly from 8000 to as high as 25,000 lbs. an hour* from each boiler. Yet in spite of this tremendous fluctuation Hays Automatic Combustion Control allows the steam supply to follow the demand faithfully with an average boiler efficiency of 82%. Evaporation has been raised from 8 lbs. in the old plant to 11 lbs. or better and the cost per 1000 lbs. of steam has been reduced from 27 cents to approximately 20 cents. CO_2 is maintained practically constant at around 13%.

This case is typical of what Hays Centralized Automatic Combustion Control is doing in hundreds of steam generating plants of all sizes, burning all types of fuel. Let us tell you what automatic control can do for your own plant.

For the complete story of this interesting application of automatic combustion control send for publication No. 40-396—its free.

NOTE TO ENGINEERS

Tear off the bottom of this ad and send with your name and address to The Hays Corporation and we will send you copy of "Automatic Combustion Control and Its Relation to Lower Steam Costs".

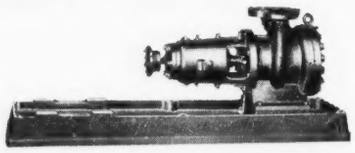
The HAYS CORPORATION

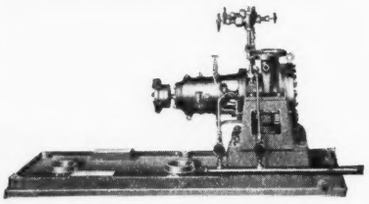
SINCE 1901 — COMBUSTION INSTRUMENTS AND CONTROL — MICHIGAN CITY, INDIANA, U.S.A.

types provide a choice between totally direct and diffused or semi-direct illumination. Direct type throws all light downward, while diffuser unit allows minimum of approximately 2½% upward light to pass through apertures above each lamp, reducing brightness contrast between ceiling and lighted area. Two-lamp balance produces power factor of over 90%, and minimizes cyclic flicker. *Westinghouse Electric & Mfg Co, Lighting Div, Edgewater Park, Cleveland, Ohio.*

Centrifugal Pumps

TYPE "SV" CENTRIFUGAL PUMPS are designed for general-service applications. Can be used for extremely high temperatures, as well as sub-zero temperatures, handling both heavy and light liquids. Capacities range from 25 gpm to 1400 gpm, against discharge pressures up to 300 lb. Pumps

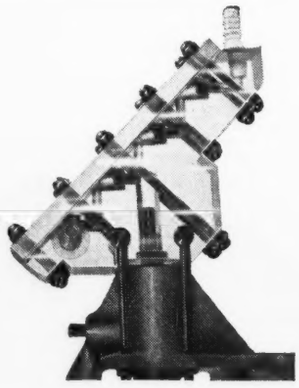




are made for maximum casing working pressure of 600 lb, and are suitable for handling liquids up to 750 F at speeds ranging up to 3600 rpm. Pumps supplied for cold service are foot-mounted, as in upper photo, and pumps for hot service are centerline-mounted. Hot-service pump is arranged with water-cooled bearings, stuffing boxes and base pedestals, including provisions for removable lagging if desired. *Pacific Pump Works, Huntington Park, Calif.*

Plastic Pump

MACHINED FROM SOLID BLOCK of Plexiglas, crystal-clear, plastic material, pump can be used for handling dilute acids, hypo-



"On a centrifugal pump handling silicate of soda at 300° F. Lattice-Braid has lasted four times as long as any other packing heretofore tried and is still giving 100% service."

"Lattice-Braid on the rotary steam valves of Corliss type steam driven air compressors has been in service over two months without any adjustments whereas packing formerly used wore out in about three weeks."

"On our expansion joints Lattice-Braid has been in service over three months without adjustment of any kind, whereas other packings have required attention after six or eight weeks and renewal within three months."

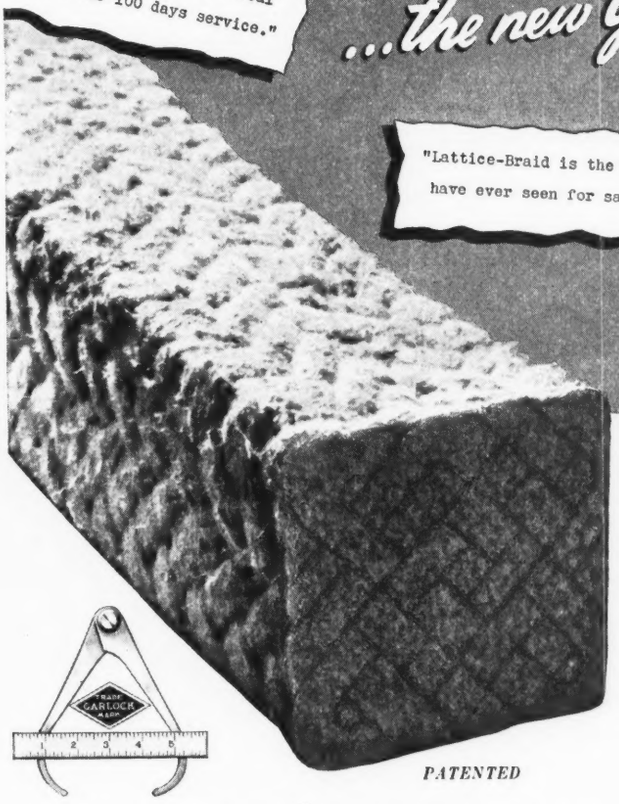
Success Story of LATTICE-BRAID ...the new Garlock Braided Packing!

"Sealing against steam and condensate on one side and against oil on the other side on the steam turbine of an underfeed stoker, which had never been satisfactorily packed, Lattice-Braid is still doing a real job after 100 days service."

"After three months service Lattice-Braid on a plunger type mine pump handling water containing excessive sediment is still performing perfectly."

"Lattice-Braid is the best packing we have ever seen for sand pump service."

"On a centrifugal boiler feed pump which formerly required repacking every second week Lattice-Braid was removed for examination after three months service and found to be in A-1 condition."



PATENTED

GARLOCK LATTICE-BRAID Packing is available in the following styles: **GARLOCK 730** for centrifugal and rotary pumps handling hot or cold water, caustic solutions or weak acids. **GARLOCK 731** for rods operating against steam, gas, acids, lye and caustic soda solutions. **GARLOCK 732** for heavy duty service against high pressure steam or hot oil. **GARLOCK 736** for centrifugal or rotary pumps handling acids or strong chemical solutions. **GARLOCK 751** for centrifugal or rotary pumps handling cold oil or water.

MANY TYPES OF SERVICE Since it was introduced several months ago, the new Garlock LATTICE-BRAID Packing has proved itself by superior performance on many types of service.

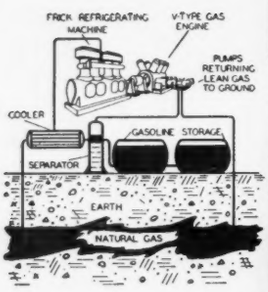
LONGER LIFE The unique structural design of LATTICE-BRAID holds strands together (even when the material is worn far beyond the serviceable limits of wear of ordinary braided packings), provides unusual flexibility and imparts semi-automatic pressure action.

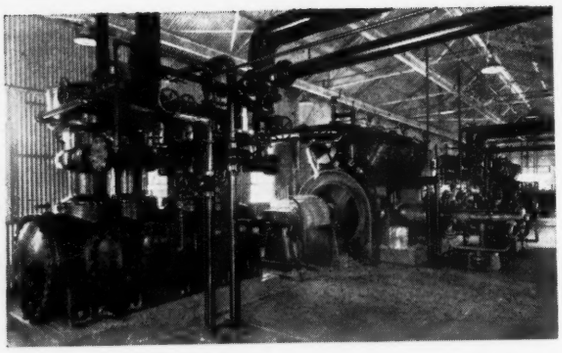
Write for illustrated folder!

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Co. of Canada Ltd., Montreal, Que.

Garlock LATTICE-BRAID





Gasoline now made from natural gas with

They're doing it near Palestine, Texas, using the patented system shown in simplified form in the sketch. Calcium chloride solution sprayed into the gas prevents the freezing of moisture in the cooler.

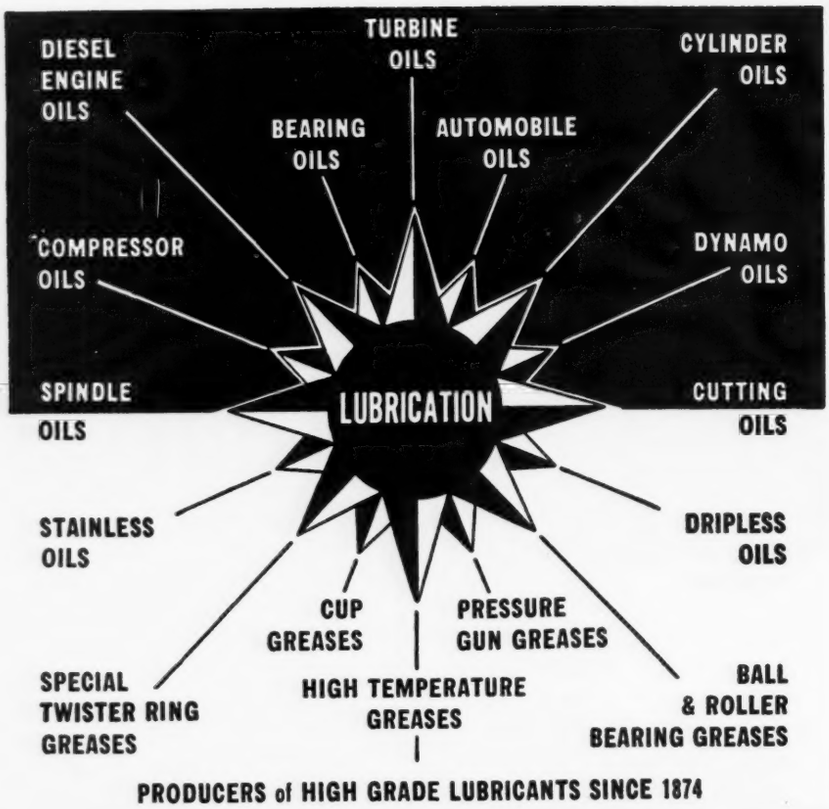
Daily production of the plant is 38,000 gallons of natural gasoline. Two big Frick compound ammonia compressors, each with four cylinders, cool 40,000,000 cubic feet of gas a day to five degrees above zero.

Another instance of how Frick Refrigeration is indispensable to industry! Whether you need dependable equipment for conditioning air, making ice, doing process work, or any other cooling service, you can rely on Frick Engineers to meet your needs. Let us quote on your requirements.

FRICK CO. Waynesboro, Penna.

TRADE FRICK MARK

Refrigeration



PRODUCERS of HIGH GRADE LUBRICANTS SINCE 1874

BORNE SCRYMSER COMPANY
17 BATTERY PLACE • NEW YORK

chlorites and other chemicals. Feature of pump is visibility, at all times, of flow of liquid being pumped, and movement of valve checks and pump piston. Pump shown has capacity of 18 gph against a maximum discharge-pressure of 150 lb, and is driven by 1/6-hp integral-gear motor. *Milton Roy, 1305 E Mermaid Ave, Philadelphia, Pa.*

Tube-Coating Machine

AUTOMATIC TUBE-COATING MACHINE applies protective coatings to interior of boilers, economizers, condensers, etc. Automatic feed-to-brush equipment consists of a pressure-feed "Apexior" container equipped with adjustable coating-pressure regulation. It operates with air-motor agitation, a single-air-fluid line and forced feed to

expanding brushes through specially constructed air turbine. With operating hose lengths up to 150 ft or more, connected to working line up to 75 ft long, operator is able to pass brush head through tube. Coating is discharged into path of rotating brush as coating unit is withdrawn. Machines are available for purchase or rental. *Dampney Co of America, Hyde Park, Boston, Mass.*

Glass Insulation

IRVINGTON VARNISHED FIBERGLAS is glass cloth base (Owens-Corning Fiberglas) impregnated and coated with heat-resisting varnishes developed especially for this purpose, and available for use as insulation by manufacturers of electric motors, generators, etc. New insulation material furnished in full-width rolls and tape of various widths and thicknesses. *Irvington Varnish & Insulator Co, 24 Argyle Terrace, Irvington, N. J.*

Tachometer

STANDCO UNIVERSAL-TYPE HAND TACHOMETER is direct-reading centrifugal type. Covers wide range and comes in four standard range combinations, covering

Fluid Drives

ABSORB SHOCKS SMOOTHLY

This 5-ton fluid clutch drive will connect compound Diesel marine engines to a gear reduction unit. This intricate casting was produced in Nickel alloyed iron by THE HILL ACME CO., CLEVELAND, OHIO, for the HYDRAULIC COUPLING DIVISION of the AMERICAN BLOWER CORP., DETROIT. The Nickel alloy cast iron provided a dense, machinable, pressure-tight, and erosion-resistant casting.

NICKEL

CAST IRONS

assure strength and soundness

These fluid clutches put more drive into America's new merchant fleet. Shown at right, 9½ ft. rotor units being assembled in Detroit plant of the HYDRAULIC COUPLING DIVISION OF THE AMERICAN BLOWER CORP. Nickel alloy cast irons assure uniformly high strength, pressure-tightness and good machinability.

Your questions about materials most suitable for special drives will be answered promptly upon request. Please address:

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET
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LOW .. in cost

You need never guess about the tabulation of Boiler Feed, Turbine Condensate, Steam, Air or other fluids when you have a Simplex Meter on the job.

Although low in first cost and maintenance and designed for use with orifices, nozzles or venturis — sturdy Simplex Meters provide an accurate summary of fluid flows that pave the way to high savings in plant operation.

There is a Simplex Meter to fit your specific needs. Write for latest descriptive bulletin No. 52.

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universally recognized as a standard method of removing
DUST, FLY ASH, FUME, MIST & FOG
from GASES

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28 years of research development and operating experience by the affiliated Cottrell Companies throughout the world is incorporated in the

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offered to meet the requirements of any problem by

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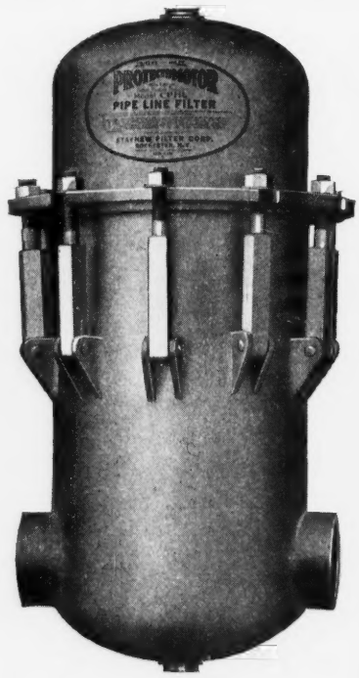
speeds between 30 and 48,000 rpm. Instruments have rotating gear shift in knurled cover for changing to five speed ranges, knife-edged pointers, large 3-in. dial and easy-to-read scales. They are direct reading and no calculations are necessary to measure rpm and fpm from the instrument. *Herman H Sticht Co, 27 Park Place, New York, N. Y.*

Water Filter

RADIAL-FIN CONSTRUCTION of air filters has been adapted for water filtration. All water passing through special fabric-filter mediums does so with minimum restriction to water flow. There are no moving parts



and large filtering area permits long periods of operation without any attention. When necessary, entire insert can be easily removed by unbolting head and removing one wing nut. Units can be arranged so that cleaning is effected by backwashing with clean water. *Staynew Filter Corp, Rochester, N. Y.*

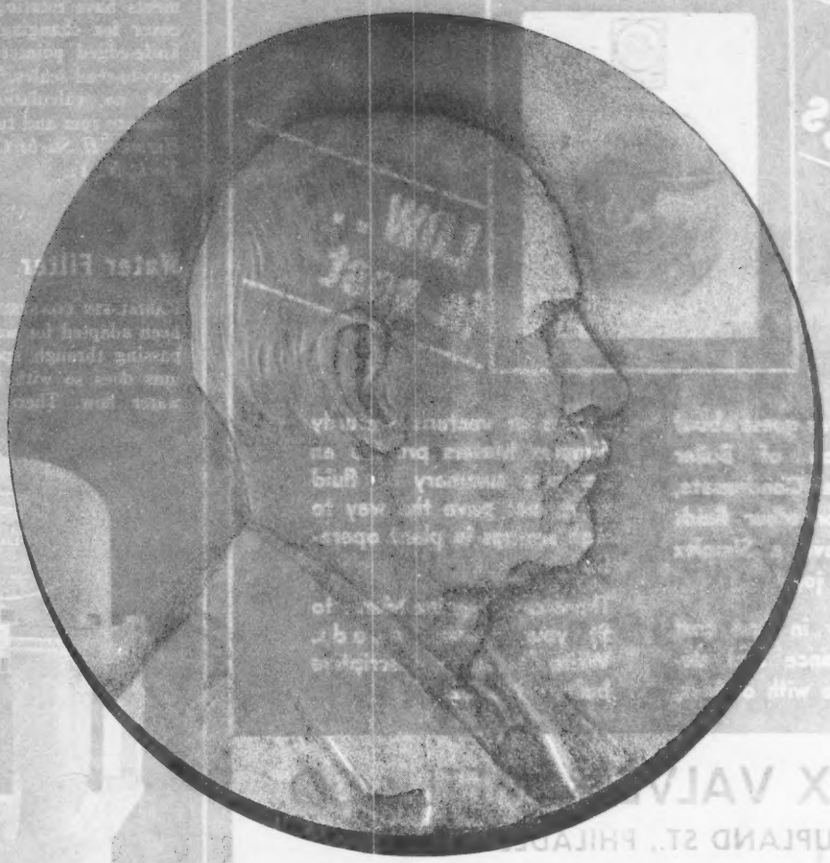
MEETINGS

American Society of Mechanical Engineers—*Spring Meeting, March 31–April 3, Atlanta, Ga. C E Davies, secretary, 29 W 39 St, New York, N. Y.*

American Society for Testing Materials—*1941 Spring Meeting and Committee Week, March 3–7, Hotel Mayflower, Washington, D. C.*

Midwest Power Conference—*Fourth Annual Meeting, Palmer House, Chicago, Ill., April 9–10. Charles N Nash, conference secretary, Illinois Institute of Technology, Chicago, Ill.*

National District Heating Association—*Annual Meeting, June 10 to 13, 1941, William Penn Hotel, Pittsburgh, Pa. John F Collins, Jr, secretary-treasurer, 1231 Grant Bldg, Pittsburgh, Pa.*



DR. EDWARD GOODRICH ACHESON WHOSE INVENTIVE GENIUS IN CREATING THE FIRST MAN-MADE GRINDING MATERIAL GAVE SUCH IMPETUS TO THE DEVELOPMENT OF ABRASIVE PRODUCTS THAT THEY HAVE BECOME ALL IMPORTANT FACTORS IN MAKING POSSIBLE VASTLY INCREASED PRODUCTION AND GREATER PRECISION THROUGHOUT ALL INDUSTRY

50 Years

Never before in history has life been so enriched by scientific discovery and industrial progress as in the half century just completed. We have seen amazing strides in means of transportation ... the automobile, the airplane, the streamlined train of stainless steel. The electric furnace has given industry new chemicals, new steels, new alloys. We have witnessed the creation of new synthetics, the perfection of the machine tool, the enormous development of mechanical efficiency in every field, and the production of countless commodities that promote and protect our way of life.

Of all these varied advances none surpass the progress made in the abrasive field. When Dr. Edward Goodrich Acheson created the first man-made abrasive fifty years ago, little did he foresee that modern abrasive products would become one of industry's most important tools for the shaping, grinding and finishing of almost every device of the useful arts. It shapes the tiny balances of our watches. It smooths the massive casting. It grinds tons of wood pulp for paper making. It fashions marble and stone, finishes wood and leather and sharpens the tools of every craft.

In other words manufactured abrasives are intimately integrated with the very structure of industrial life ... meeting its fundamental needs, furthering its progress, translating yesterday's luxuries into today's commonplace necessities.

It is with justifiable pride, therefore, that we of The Carborundum Company pay tribute to the late Dr. Edward Goodrich Acheson in commemorating the Fiftieth Anniversary of his creation of silicon carbide, trade named "Carborundum", the first man-made abrasive. It is fitting also that we choose this occasion to acknowledge the splendid cooperation of our friends in industry in bringing his work to fruition and to rededicate this Company's efforts to a continuing service to industry and to the betterment of America's way of life.

Frank J. Tone

FRANK J. TONE, President,
THE CARBORUNDUM COMPANY,
NIAGARA FALLS, N. Y.

THESE FLOORS ALSO SERVE AS VENTILATORS

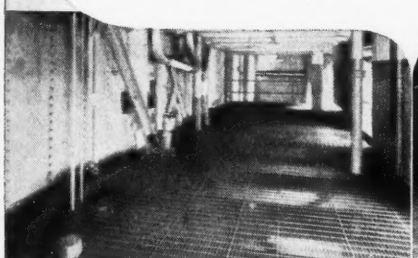
FLOORS of Open Steel Grating are factory-fabricated from a combination of structural members rigidly connected by interlocking, welding or riveting. And because of their open construction, they provide a free circulation of air—over, under, around and *through* their surface.

Because they are open in construction, Open Steel Grating floors and steps do not accumulate dirt, dust, grease, oil or moisture on their bar edges. Used for outside walks, they do not collect snow, ice or water. They are virtually "self-cleaning."

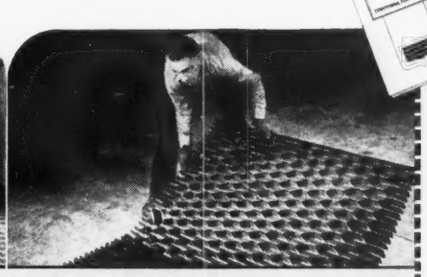
Floors of Open Steel Grating are non-slip—safe—do not wear smooth. Their non-slip surface remains as long as the floor itself. For more information on this durable, fireproof, rigid type of floor that is factory-fabricated to *your* individual requirements and can be quickly and easily installed, write today for the free booklet shown below.

This seal is your assurance OPEN STEEL FLOORING INSTITUTE INC. *of a quality product*

OPEN STEEL FLOORING INSTITUTE, INC.

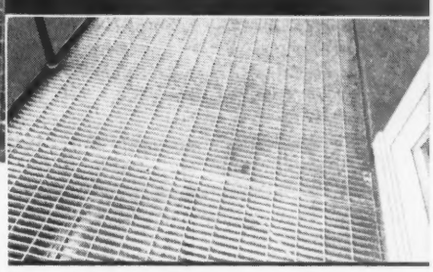


NON-SLIP SAFETY. Open Steel Gratings cannot accumulate skid-inducing substances—provides an even, non-slipping, stumble-proof surface.

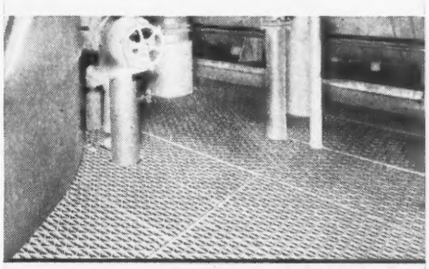


LIGHT WEIGHT. Every pound of material is used, with maximum efficiency to carry or distribute loads—meaning less dead weight, lighter supports, reduced erection costs.

FACTS ABOUT OPEN STEEL GRATING



SELF-CLEANING. Open Steel Gratings do not accumulate dust, dirt, grease, oil or moisture. Their construction makes them virtually self-cleaning.



ECONOMICALLY INSTALLED. Every section of Open Steel Grating is built to the requirements of the individual job. This factory layout insures speedy installation and perfect fit.

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Pittsburgh, Pennsylvania

Send me, without obligation, your new booklet, "New Ideas in Functional Floor Design."

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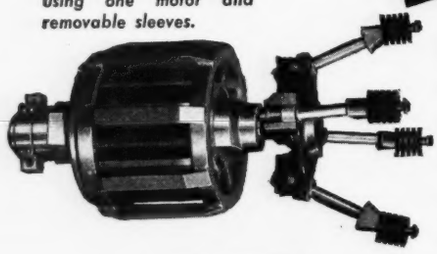
BIG TUBES LITTLE TUBES
CURVED TUBES BENT TUBES
ALL TUBES

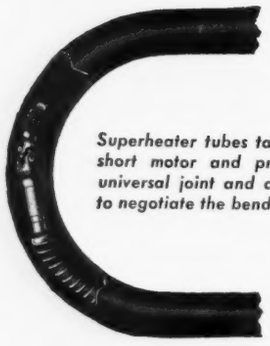
Clean them WITH .. LAGONDA-LIBERTY TUBE CLEANERS

Cleaning of several sizes of large tubes or pipes can be accomplished by using one motor and removable sleeves.

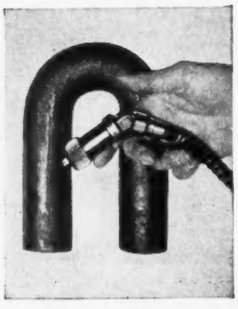


If a tube can be cleaned mechanically, Elliott has the cleaner to do it! This means a lot of tube cleaners. It also means a lot of experience. Both of these factors are essential to the correct cleaner selection for *your* particular tube cleaning job.

The cleaners pictured at the left are *extreme cases,* which will give some idea of the many sizes and types that are ready to do a speedy, time-saving job for you. Elliott engineers, at Tube Cleaning Headquarters, are eager to help you in your selection of the right cleaners for your particular work.



Superheater tubes take a short motor and proper universal joint and cutter to negotiate the bends.



For extremely short radius bends a compact cleaner with hinge coupling and telescoping cutter is available.

You'll want the "inside story" on tube cleaning. It's all in the Lagonda-Liberty Bulletin. Write for your copy today.

ELLIOTT COMPANY
LAGONDA-LIBERTY
Tube Cleaner Dept., SPRINGFIELD, OHIO
District Offices in Principal Cities Y-162

Measurement of Condensate Solids

(Continued from page 97)

general curve for this correction.

A recommended procedure for plant routine tests is as follows. Measure approximately one liter of condensate into the flask shown in Fig. 1. For accurate results the flask should be held in a water bath a 77 F. Connect the outlet of the flask to a suction pump and bubble air through for 30 minutes to remove carbon dioxide. Connect the cell to a conductivity meter and read the conductance and the corresponding temperature. If the meter reads in resistance only, conductance in micromhos equals the cell constant times one million divided by resistance in ohms.

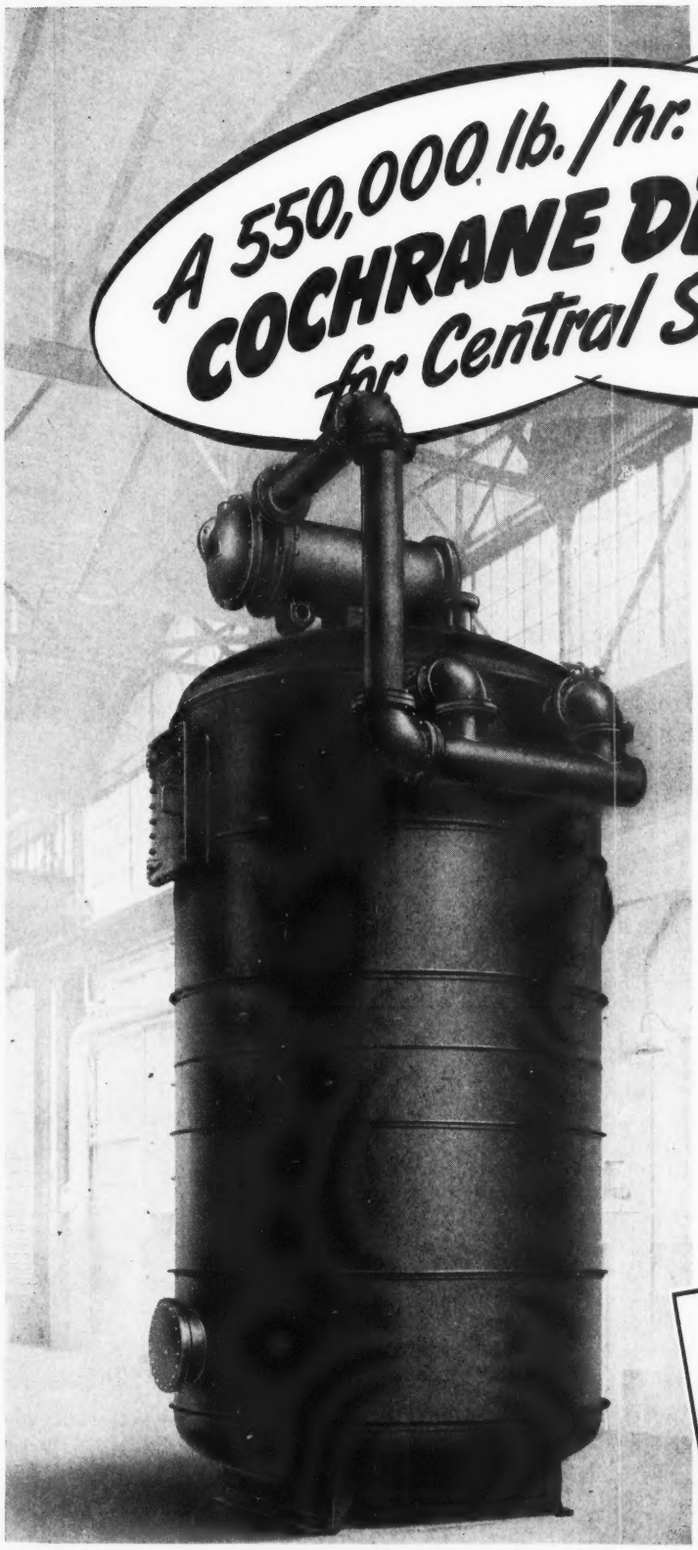
A 50-ml sample is removed from the flask with a pipette and tested for ammonia nitrogen by adding one ml Nesslers' reagent and comparing the color developed with known standards in a colorimeter. It is not necessary to add copper sulphate and sodium hydroxide to the sample as is given in most directions for direct Nesslerization.

The soluble solids in parts per million may then be read directly from the curve shown in Fig. 5 by using the line corresponding to the ammonia nitrogen content. The lines on this chart are corrected for the conductance due to the residual carbon dioxide remaining in the sample after bubbling air through for 30 minutes.

Our original thought was to develop a plant test for soluble solids in condensate, which would involve conductance measurements only. We found it possible to eliminate direct chemical tests for carbon dioxide by a purified air method, but this does not reduce the ammonia to a low enough value. It is necessary therefore to make a simple chemical test for ammonia and correct for this in terms of conductance.

We have done a large volume of work in the laboratory in arriving at our present conclusions, and believe we have developed a simple, yet accurate, method of field test which any operator can carry out.

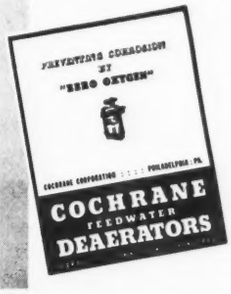
JOB EVALUATION AND MERIT RATING—A MANUAL OF PROCEDURES.—*By Eugene J Benge. 71 pages, 26 charts, loose-leaf leatherette binder. Published by National Foremen's Institute, Deep River, Conn. Price $7.50.* This volume is actually a manual of procedures for an employer, containing illustrative charts and practical case material, desiring to establish a fair and defensible wage scale for either individual or collective-bargaining use.



A 550,000 lb./hr. COCHRANE DEAERATOR for Central Station Make-up

IN the Cochrane Deaerator illustrated, restricted floor space resulted in the selection of the vertical shell design. Boiler feed from three different sources, including make-up and condensate, is deaerated and stored in the shell which has extra height to provide surge capacity.

The Cochrane Organization with its thoroughly trained sales staff, and wide variety of deaerator designs, can be of tremendous help in the selection of deaerating equipment. Thus prospective users are assured that their requirements will be satisfied economically with maintenance of high engineering standards.



SEND FOR COPY OF THIS BOOK

Cochrane bulletin on deaeration discusses fundamental requirements of deaeration, and how these are accomplished with the Cochrane Deaerators.

The many advantages of the down-flow principle, sealed tray stack and other features are fully discussed and illustrated. Send for publication 2540.

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WATER SOFTENERS • DEAERATING HEATERS • DEAERATORS • BLOW-OFF EQUIPMENT • VALVES • FLOW METERS

ARE WIRE FAILURES DRIVING YOU NUTS?

Are shorts knocking out your dried out, age-wizened lighting circuits? Are oil-rotted motor leads quitting on you and tieing up production? Are your power and control cables getting as brittle as macaroni in the hot spots? Are you hopping from one rewiring job to another *and then going back to do the same thing all over again?*

If that's your situation don't blame operating conditions that you can't change. What you need is a wire designed especially for severe service—one that will prevent illumination blackouts, machine outage, lost production and unnecessary maintenance expense! And that's just what you'll get if you wire with Rockbestos because every wire, cable and cord in the line is *permanently insulated* against the service interruptions caused by heat, fire, alkalies, caustics, corrosive fumes, moisture, oil, grease and aging.

1. Rockbestos A.V.C. Power Cable
2. Rockbestos A.V.C. Motor Lead Cable
3. Rockbestos A.V.C. Boiler Room and Lighting Wire

Our catalog makes it easy for you to select the wires that will take the trouble spots out of your wiring system. It shows many of our 118 maintenance-eliminating standard constructions and lists typical applications in which they are used. Send for a copy and don't hesitate to ask for samples if you want to get the inside story on *permanent insulation*. Rockbestos Products Corp., 990 Nicoll St., New Haven, Conn.

TEN TESTED ROCKBESTOS VALUES that will pay you dividends

1. HEATPROOF
2. FIREPROOF
3. PERMANENT
4. Lower maintenance cost
5. Resists heat and vibration
6. Saves work
7. Oil, Grease and Moisture resistant
8. High overload capacity
9. Permanently flexible
10. Greater carrying capacity

Also refer to McGraw-Hill Electrical Buyers Reference.

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Rockbestos 600 Volt All-Asbestos Power and Rheostat Cable — No. 18 AWG to 1,000,000 CM — one of 118 different permanently insulated wires.

Heat Recovery

(Continued from page 79)

in the engine exhaust, 650,000 Btu can be recovered in steam at 5 lb g or 700,000 Btu in the form of hot water. Following the dotted lines through the lower left-hand chart, it is seen that approximately 600 lb of steam at 5 lb g or 7000 lb of hot water at 160 F can be produced.

The Foster Wheeler Corp has developed the data shown in Table II showing the steaming capacities of their waste-heat boilers for both 2- and 4-cycle engines, and at different steam pressures. This table indicates the range of steam production from a diesel-engine exhaust, and is self-explanatory.

Increasing the backpressure on a diesel exhaust with a consequent reduction in power output has long been a worry of the designer and operator. Studies show that a backpressure increase of 2.2 lb, or 50 in. of water, reduces the engine output approximately 3%, while a backpressure of 0.5 lb (13.8 in. of water) results in a decrease of less than 1%.

Some designers claim they can reduce backpressure by using waste-heat boilers. Others contend that a draft loss of about 3 in. of water is necessary through the boiler in order that the exhaust gas have sufficient velocity to provide reasonable heat-transfer rates.

Installation records of 4-cycle engines equipped with waste-heat boilers show that a backpressure of from 3 to 4 in. through the boiler does not apparently affect engine economy or performance. While there is considerable difference of opinion as to the amount of backpressure a 2-cycle engine will permit, waste-heat boilers imposing as much as 3½ in. backpressure on this type of engine do not apparently affect engine operation.

Since waste-heat boilers normally operate at relatively low steam pressures, the only auxiliaries necessary are sight gage glass, safety valves, feed inlet valve (preferably automatic), boiler blow-off connection, indicating steam pressure gage, and gas-pressure indicator to engine backpressure. Where several engines exhaust to a common boiler, suitable gas dampers should be provided between the engine exhaust and the exhaust manifold to the boiler.

In addition to waste-heat boilers, there are available waste-heat water heaters for applications where it is desired to obtain hot water rather than steam from exhaust waste heat.

How to properly size coal for efficient combustion

You'll find the answer in this new "AMERICAN" Engineering Bulletin . . JUST OFF THE PRESS . . . . . Write for Your Copy–*TODAY!*

A Great ACHIEVEMENT
Installation prominent Eastern Public Utility
CRUSHING COAL AT LESS THAN ONE CENT PER TON
WITH THE
American Ring Crusher Type "S"

Fully Illustrated— Concise—Useful

Prepared for engineers by the engineers who originated the principle involved in the Rolling Ring Crusher.

Contains valuable test data, as well as important information on the sizing of coal and its relation to ashpit loss, together with simple tables for selecting crushers of the proper capacities for various sizes of coal with horsepower requirements.

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Gentlemen:

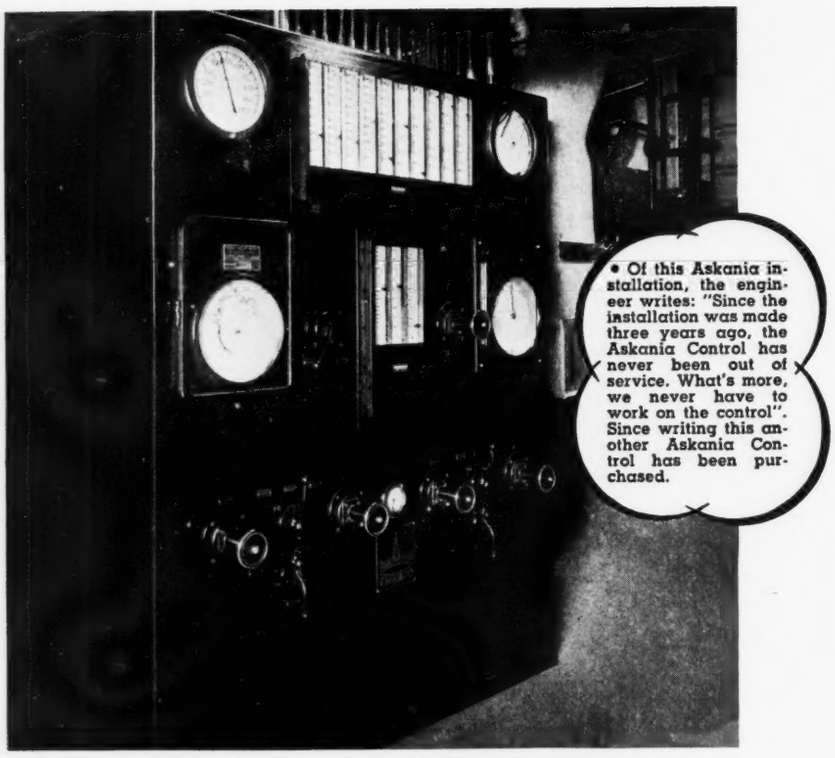
Kindly send me a copy of your NEW Bulletin on Coal Preparation. It is understood that this request incurs no obligation on my part.

Name .....

Company .....

Position .....

Address .....


• Of this Askania installation, the engineer writes: "Since the installation was made three years ago, the Askania Control has never been out of service. What's more, we never have to work on the control". Since writing this another Askania Control has been purchased.

Can you afford NOT to have Askania Control?

OF course you *want* the best there is in combustion control but . . . there is always that human tendency to balk at initial cost and seek to justify something not so good by saying in effect: "Askania is better than I need".

The answer to this is written into the operating record of every Askania-equipped boiler plant. From smallest to largest, they show that you can't afford NOT to have the precision and trouble-free operation of Askania Regulation.

You can't afford NOT to have the unequalled sensitivity, yet inherently stable control, of the exclusive Jet Pipe Principle. You can't afford not to have this system that gives you a freedom from maintenance that would make it the most economical control even if its higher efficiency were completely disregarded.

WRITE TODAY for the ASKANIA Power Plant Bulletin. It will convince you that the only way to get Askania results is to INSTALL Askania.

ASKANIA CHICAGO

ASKANIA REGULATOR COMPANY

Corner 16th and Michigan, Chicago, Illinois

ASKANIA *Combustion* CONTROL

"Boiler Booster"

(Continued from page 81)

temperatures which mean lower volumes, but this point must be investigated in each case.

Mr LaMont believes there should be no difficulty in connection with circulation in the old boiler and with steam liberation in the existing drums. He points out that the load on the old boiler is actually reduced, and that discharge from the booster tubes enters the drums above the water line. Here the separation is a problem of removing water from steam rather than liberating steam bubbles from water, because of the high steam-water ratio, by volume. Baffling at the point where the tubes enter the drum steam space will help mechanically separate the water.

When a booster is applied to an existing boiler generating superheated steam, the lower furnace temperature and greater steam quantity will tend to reduce final temperature (this is true of any waterwall additions). This can be overcome by adding superheater surface, if possible; by removing some boiler surface to better expose superheater surface; or by adding a "superheater booster" as described previously.

Present experiments and design activities aim at overcoming mechanical difficulties encountered in operating the Altman unit. Substituting welded for riveted seams in the inner casing is expected to eliminate troubles caused by rivet failure. To avoid carbonization and impingement, various burner tips are being tried to find one with the desired flame shape.

Readers' Problems

(Continued from page 111)

will not be affected; the pump will start and stop under control of the float switch and the rate of pumping will not be of much importance. This hookup has certain definite advantages, especially if the pump will not operate at the exact capacity required by the cooler. Of course, this last scheme requires a sump pump and a float control, which will add somewhat to the installation cost.

Bloomfield, N. J. J O G GIBBONS

Pump Will Handle Job

AS JPC DOES NOT STATE the length of the cooler, the approximate head can be assumed as 10 lb. The total head on the pump will be $40 \times 0.434 + 10 = 30$ lb

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● Much as vitamins fortify the body with greater vitality and resistance, minute and controlled amounts of substances added to metals and alloys greatly increase their efficiency, usefulness and life.

The research laboratories of Revere Copper and Brass Incorporated have made an intensive study of this metal "vitalizing" process. It has resulted in many improved applications of copper and its alloys. Three of these applications are especially notable.

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2. A sheet copper with a high resistance to "season cracking."

3. Brasses, bronzes and other alloys with finer "working" and "machining" qualities.

The Revere Technical Advisory Service is armed with much specialized knowledge of new developments in the copper family. Its services are available at no obligation for individual problems to which copper or copper base alloy may be the answer.

REVERE

COPPER AND BRASS INCORPORATED

Executive Offices: 230 Park Avenue, New York, N. Y.

Sales offices and distributors in most of America's major cities

MILLS: BALTIMORE, MD. • TAUNTON, MASS. • ROME, N. Y. NEW BEDFORD, MASS. • DETROIT, MICH. • CHICAGO, ILL.

There's a revolution going on in BOILER FEEDING

A FEW TYPICAL USERS

DuPont Company, El Monte, Calif.
Holly Sugar Co., Torrington, Wyo.
Van Camp Milk Co., Angola, Ind.
Dry Zero Corp., Buchanan, Mich.
Champion Paper & Fibre Co., Saundersville, Ga.
Cannon Mills, Social Circle, Ga.
U. S. Naval Air Station, Pensacola, Fla.
Hotel Roosevelt, New Orleans, La.
Hiteman Leather Co., W. Winfield, N. J.
Union Laundry, Newark, N. J.

EVERY once in a while a brand new idea comes along that makes accepted methods look about as snappy as a 1910 automobile. It may be as simple as putting zippers on clothing and hand bags. But whatever it is, if it does a job better, or at lower cost, American Industry wants it — and *needs* it.

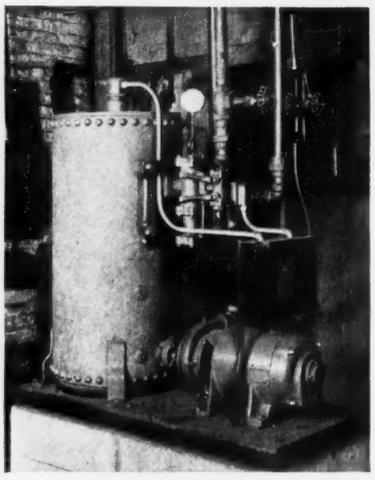
The Johnson "Pressure Equalizing" Pump is exactly that kind of a basically-better idea. It outmodes so completely every known method of pumping water to a boiler, that Johnson dares to claim that the "Pressure Equalizing" High Temperature Return System will:

1. **Cut pumping cost as much as 60%.**
2. **Cut fuel cost 10% to 15%.**
3. **Cut pump maintenance cost to the bone.**

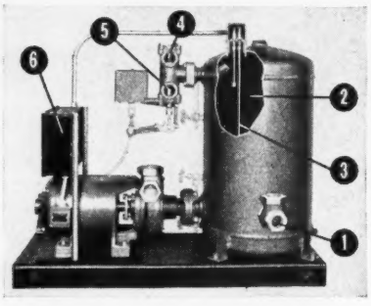
These savings are accomplished by the simple short-cut of admitting boiler pressure to the pump chamber while the pump operates. Eliminated is the task of fighting against boiler pressure — a task that requires considerably more horsepower, higher speed, and high-maintenance construction in the ordinary type of boiler feed pump.

So simple, so sound is the operating principle of this revolutionary new pump that leading firms and power plants have been quick to adopt it. Their wholehearted endorsement is proof that the "Pressure Equalizing" method, found exclusively in the Johnson Pump, can effect the same remarkable saving in your plant.

Write for new Bulletin

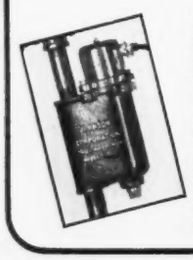


● Installation view of the Johnson No. 250 SH Pressure Equalizing Boiler Feed Pump. This unit is fully A.S.M.E.-approved, designed for boilers up to 250 Hp., 150 lbs. pressure. Smaller sizes are available, to suit every plant—for boilers as small as 30 Hp.



HOW IT WORKS—Condensate enters inlet (1) filling equalizing chamber (2) until water across electrodes (3) completes circuit to relay (6). This operates two way valve, admitting steam from boiler through inlet (4) thus equalizing chamber with boiler. Pump is started simultaneously—*its only task to raise water a few feet to boiler level, not overcome boiler pressure.* When contents are pumped into boiler, inlet (4) is closed, pump is stopped and steam is exhausted to a condensing receiver through port (5). Cycle then repeats.

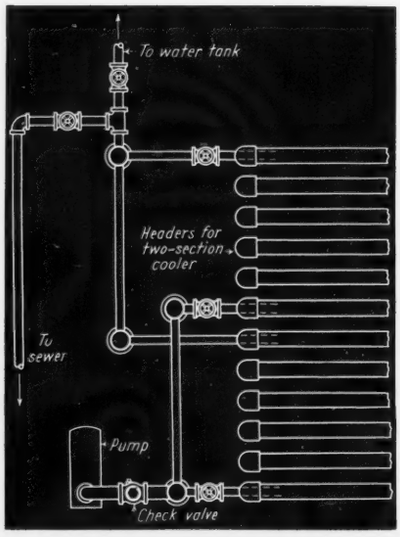
TO COMPLETE YOUR BOILER FEED SYSTEM



● Use the automatic Johnson Boiler Water Level Control. Dependable, low-cost, easily installed. Utilizes new electrical operation — a perfect teammate for the Johnson "Pressure Equalizing" Pump. Can be used to control boiler feed pump, open make-up water valve, or sound low water alarm.

Products of The Johnson Corporation

865 WOOD STREET, THREE RIVERS, MICHIGAN



approximately. The suction pressure is 15 lb so the net head will be 15 lb. It can be seen that a 5 hp centrifugal pump of size and speed given is more than ample.

The sketch illustrates a 20-pipe double-suction ammonia condenser with a pump and piping layout similar to that in use in our plant. This hookup tends to give more uniform water distribution because the sections are split in two, and also enables any one section or half section to be isolated for repair. Water may be directed to the sewer in case of pump trouble.

Bronx, N. Y. ANTHONY GREER

Answers to Jan Question 2

Pointers on Operation

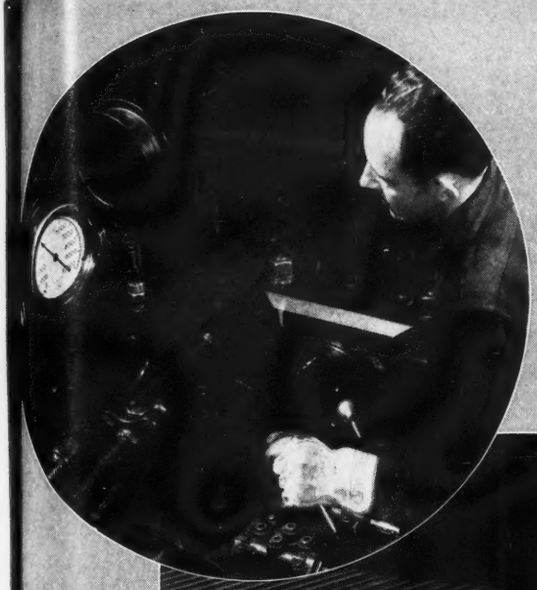
LT MENTIONED ADJUSTING THE FIRE to the size of the coal. I would suggest that with any size of coal, the fire be carried just heavy enough to be able to distinguish every burning lane from bottom to top, paying particular attention to the top of the tuyere row to see that it opens. I also suggest that LT provide an 8- or 10-in. observation door at the top and side of the furnace, about 28 in. above the top tuyeres. This will permit cutting slag and clinker loose from the front wall and top tuyeres, which means a lot in underfeed stoker operation.

It will also help the smoke condition to lengthen the secondary ram stroke a little when the load lightens up and to shorten it when the load gets heavier. If the fire is handled in this way, and the flames made to take a 60-deg angle from the front wall, there should be no smoking under any load condition.

Ottumwa, Iowa F L STOCKER

Test with Draft Gage

WHILE LT DOES NOT MENTION how his boilers are arranged in relation to the chimney and how the breechings lead to it, it is safe to assume that the trouble lies either in the arrangement of exit-gas passages or of the dampers. It is evident that



This moving finger writes:

"INSURANCE AGAINST SHUT-DOWNS"

● Up goes the indicator on the dial—up, up past the 1000-pound mark to 2000, 3000, 4000, 5000 pounds or more, depending upon the size and gauge of the Republic ELECTRUNITE Tube being tested hydrostatically. The tube is vibrated while under pressure. Then the pressure is released and down comes the indicator—a finger that has written "SAFETY" for another boiler user.

Why is this test made at pressures so far in excess of the 1000-pound A. S. M. E. code requirement? To provide insurance against shut-downs by making certain that every ELECTRUNITE Tube will be capable of carrying as much overload as the steel itself can withstand.

ELECTRUNITE tests are made at pressures within 20% of the minimum yield point of the steel. For example, a 3″ x 12 ga. tube is tested at 1900 pounds, a 2″ x 13 ga. at 2550 pounds and a 1″ x 13 ga. at 5700 pounds. And, although extremely high in test value, such pressures are safe to use because they are held below the point where the steel or tube structure might be weakened by excessive strain.

The next time you buy, build or retube a boiler, think of this test made to provide you with better tubes. It is only one of a long series that insure easy installation, low costs, long life and protection against shut-downs when you use ELECTRUNITE Boiler Tubes. There are many other interesting facts in the full story. Why not ask us to send you literature? Steel and Tubes Division, Republic Steel Corporation, Cleveland, Ohio.

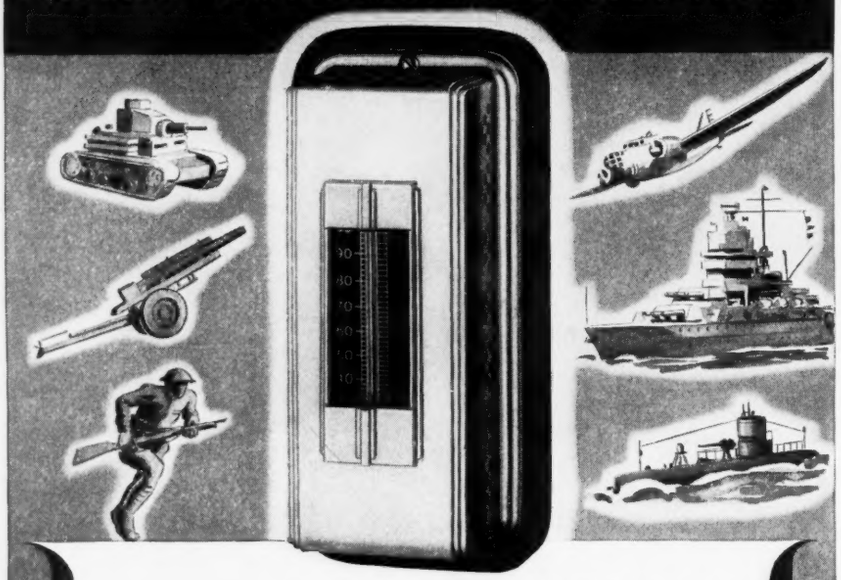
REPUBLIC

REG. U. S. PAT. OFF.

ELECTRUNITE

ELECTRIC RESISTANCE WELDED BOILER, CONDENSER AND HEAT EXCHANGER TUBES

PRECISION MACHINERY
MUST BE BUILT UNDER
PRECISE TEMPERATURE CONDITIONS



HERE'S HOW JOHNSON AIDS PRODUCTION

Automatic temperature control equipment is an important consideration when "machining up" for defense orders. When JOHNSON is called upon to furnish and install such apparatus, there's no delay. The entire problem is solved by Johnson men, from preliminary engineering recommendations down through manufacturing and installing the equipment required for proper automatic temperature and humidity control. There is no division of responsibility. It rests entirely in the hands of the nation-wide Johnson organization.

Johnson engineers have intimate knowledge of many manufacturing processes. For example, ask them about International Standards for the temperature of rooms in which metal parts for precision machinery are measured. Special problems like that are the regular order of business for Johnson technicians and sales engineers. Ask to have one of them call or send for descriptive bulletins. No obligation, of course.

A FEW OF MANY JOHNSON INSTALLATIONS WHICH TIE IN WITH NATIONAL DEFENSE WORK

Scovill Mfg. Co. (fuse cap reloading department), Waterbury, Conn.
Hamilton Standard Propellers Div. of United Aircraft Corp., East Hartford, Conn.
Pratt & Whitney Aircraft Div. of United Aircraft Corp., East Hartford, Conn.
Grumman Aircraft Engineering Co., Bethpage, N. Y.
Picatinny Arsenal, U. S. War Dept., Dover, N. J.
Wright Aeronautical Corp. (motor packing & shipping bldg.), Paterson, N. J.
Eclipse Machine Div., Bendix Aviation Corp., Elmira, N. Y.
Ohio Crankshaft Co., Cleveland, O.
Ford Motor Co., Aircraft Bldg., Rouge Plant, Dearborn, Mich.
Kearney & Trecker Corp. (machine tools), Milwaukee, Wis.
Kelsey-Hayes Wheel Corp., Plymouth, Mich.
E. I. du Pont, de Nemours & Co., Indiana Ordnance Works, Charlestown, Ind.
E. I. du Pont, de Nemours & Co., Millington, Tenn.
North American Aviation, Inc., Dallas, Tex.
Naval Air Station, U. S. Navy Dept., Alameda, Calif.
Consolidated Aircraft Corp., San Diego, Calif.

JOHNSON
Automatic TEMPERATURE AND AIR CONDITIONING Control

JOHNSON SERVICE COMPANY, MILWAUKEE, WIS. & BRANCHES IN PRINCIPAL CITIES

at certain times the large boiler causes eddy currents in the ducts in such a way that the actual draft to the smaller boilers is blanketed off and they do not get their share.

If a draft gage were installed in the last pass of the furnaces at the two smaller boilers, it would show a positive instead of a negative pressure. There might be a slight vacuum in the last pass but it could be that it was inadequate to reach back to the furnace proper where the vacuum should be at least 0.01 in. Hg. I recommend installing draft gages in the last pass of the two smaller boilers and also providing connections to the furnace proper, to give full draft information on both units. By experimenting with the dampers, especially on the large boiler, and by watching the gages, LT can soon find out where the trouble is. To overcome it he may have to rebuild part of the breechings so that there will be a free passage from each boiler to the chimney.

As only the chimney height was given, we must assume that it is big enough to handle exit gas from three boilers. Likewise the forced-draft system can be checked off the trouble list, which leaves the finger pointing right at trouble between boiler and stack.

Bismarck, N. D. LESLIE BRADLEY

Too Much Furnace

I AM INCLINED TO BELIEVE that LT is suffering from a case of too much furnace. If the furnace were the right size he would not be able to do all of the things he has mentioned, without having experienced many things of which he says nothing. For instance, the smoking periods come and go without any apparent reason, which leads me to think that the load is just on the dividing line between good conditions and poor conditions, so that when the draft, or the coal feed, or the coal changes the least amount, the conditions go over on the wrong side and produce smoke.

In this connection, it should be remembered that if the proper amount of air is going into the furnace with the coal, and the chimney is so controlled that it just takes the gases away from the fire and no more, the furnace will work economically and there will be no smoke. When you make smoke with your furnace, you are not burning all of the gases. That is to say, you are short on oxygen so that you are producing CO and procure carbon which is smoke, all for the lack of one atom of oxygen. With the extra atom of oxygen the gas would have burned to CO_2 and there would not have been any smoke. Again if you were carrying an economical load on the boilers, you would not be able to keep the fire just of the right thickness. There would be another set of conditions to manage which would call for some of your attention.

I suggest that LT close the uptake damper as far as he can without making the furnace smoke and watch the furnace closely. The furnace temperature will rise and so will steam pressure; your smoke will recede. However, this will be fine except that if the steam rises much, he will have to close off the air from the furnace

COSTS LESS

to operate the Boiler Room

CASH STANDARD

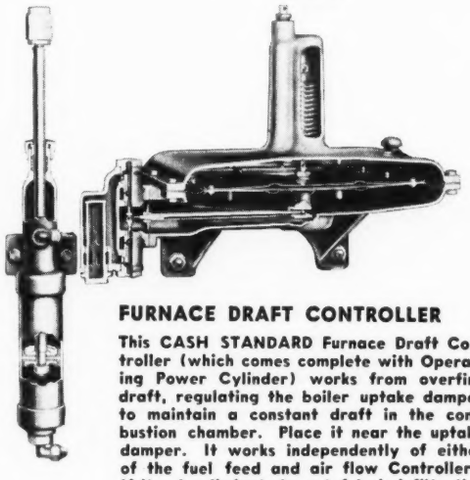
AUTOMATIC COMBUSTION CONTROL

Cuts your Fuel Bill

☆

You can bring down the costs in your boiler room and at the same time boost your boiler room performance through the simple means of Automatic Combustion Control. CASH STANDARD offers you systems for this profit-producing control specifically designed to meet every requirement — whether you have a stoker, pulverizer, oil-burning, or gas-firing equipment on your boilers. Here's how you operate your boiler room at less cost — CASH STANDARD Automatic Combustion Control cuts your fuel bill, yet gives you more steam — plus this, you materially reduce maintenance costs — you hold your steam pressure within close limits — and you will find that your boiler room operators will have more time for other important duties.

It's not costly to purchase CASH STANDARD Automatic Combustion Control — in fact CASH STANDARD Furnace Draft Controller which alone gives you many cost-saving benefits can be bought for as low as $98 — a complete system can be purchased for as little as $290.

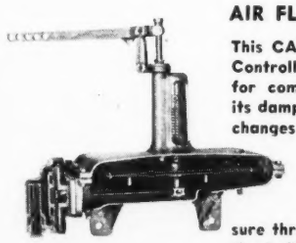


FURNACE DRAFT CONTROLLER

This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper to maintain a constant draft in the combustion chamber. Place it near the uptake damper. It works independently of either of the fuel feed and air flow Controllers. If it only eliminated wasteful air infiltration it would be a profitable investment.

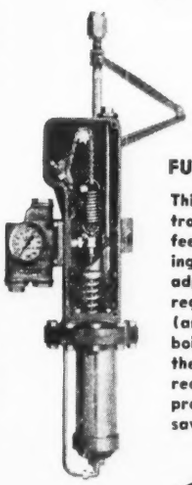
Ask for Bulletin No. 300

This bulletin gives complete facts on the entire line — write for a copy — no obligation.



AIR FLOW CONTROLLER

This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.



FUEL FEED CONTROLLER

This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.

OIL CIRCULATOR

The purchase of this oil circulator is optional. All three Controllers shown above can be properly operated by clean water, but it is preferable and cheapest in the long run to operate with this CASH STANDARD Oil Circulator — price $108. equipped with 110-220 v. 60 cy. motor.

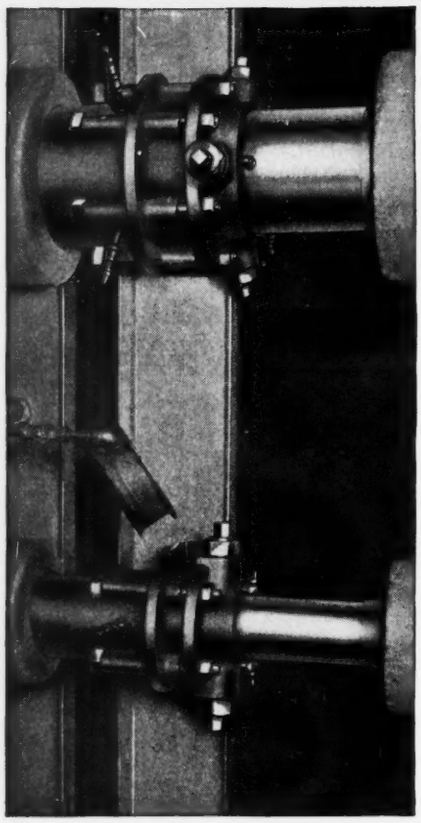
A. W. CASH COMPANY

DECATUR, ILLINOIS

CASH STANDARD

CONTROLS . . VALVES

YARWAY
GUN-PAKT EXPANSION JOINTS

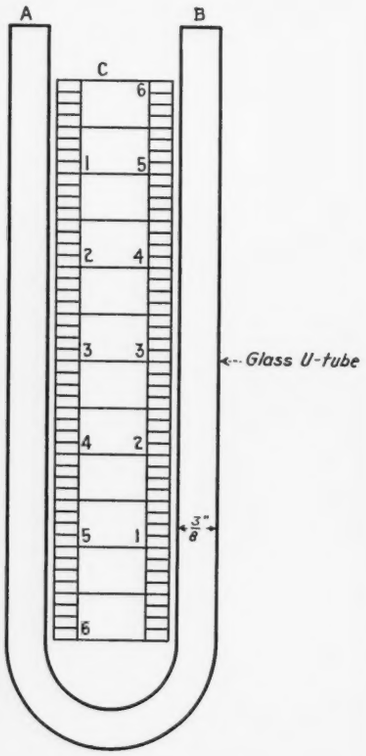


Big Automobile Company Uses 67 Yarway Joints

First purchased 3 years ago. Reordered 7 times to present total of 67 Yarway Gun-Pakt Joints, ranging in size from 3 in. to 14 in.

Why don't you select the Expansion Joint that is packed under full steam pressure. A twist of a wrench forces a special semi-plastic packing into the stuffing box by means of integral pressure guns. No need to remove old packing. New packing rejuvenates the old. No need to shut off steam. Write for Catalog EJ-1907.

YARNALL-WARING CO.
100 Mermaid Ave., Phila., Pa.



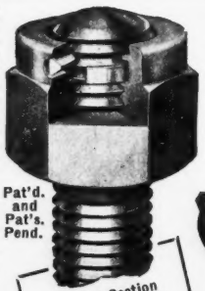
as the boiler will blow off. To do this he will need to cut down wind-box pressure; if the wind-box pressure cannot be cut down enough, then there are either too many boilers on the line or the grate surface is too big for the load.

LT should then check the grate surface. In the average it takes $\frac{1}{3}$ sq ft of grate surface for 1 hp of boiler capacity or a 250-HP boiler should have $\frac{1}{3}$ of 250 =83.3 sq ft of grate surface. Then, if there is too much grate surface, cut it down. This may usually be done by using firebrick for hand-fired boilers, or by slowing up the travel of the coal and air feed.

It should be remembered that measurement is quite necessary around the boiler plant in order to get what is coming in the shape of results. While it takes about 13 lb of air to burn 1 lb of coal, more or less according to the kind of coal, there should be a draft gage to measure the draft over the fire. One can be made by bending a small piece of glass tubing into U-shape, then fastening it to a small piece of board. Cut off a piece of a yardstick and fasten it between the two legs of the U-tube, then connect one end of this U-tube to the furnace over the fire and the other end leave open to the atmosphere. Fill the tube with water so that the water stands about the middle of the scale. Whatever the differential draft is over the fire will be read in the difference in the height of the column of water. This piece of apparatus may be connected either over the fire, in the back pass, or anywhere it is desired in the gas tract.

Even though LT's plant is on one railroad, there must be track connections to many mines. It would pay to make a careful analysis of all of the different coals he can get. He might also get the coal with the highest ash fusibility, which will mean less trouble with clinkers.

Perrysburg, Ohio W H GROVER



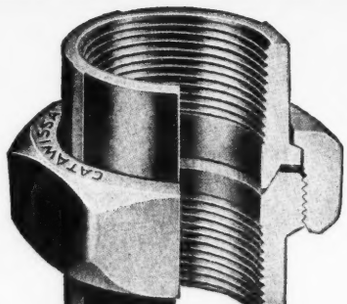
UNSHAKO
Reg. U. S. Pat. Off.
Self-Locking Nut

THROTTLES VIBRATION

Sure protection for valuable equipment, "Unshako" never fails in its grip!
The built-in, self-energizing locking ring is always on guard . . . ready to spring to life and prevent any backing off tendency. The "Unshako" does not retard assembly and can be used many times over. Details?

STANDARD PRESSED STEEL CO.
BOX 577, JENKINTOWN, PENNA.

CATAWISSA

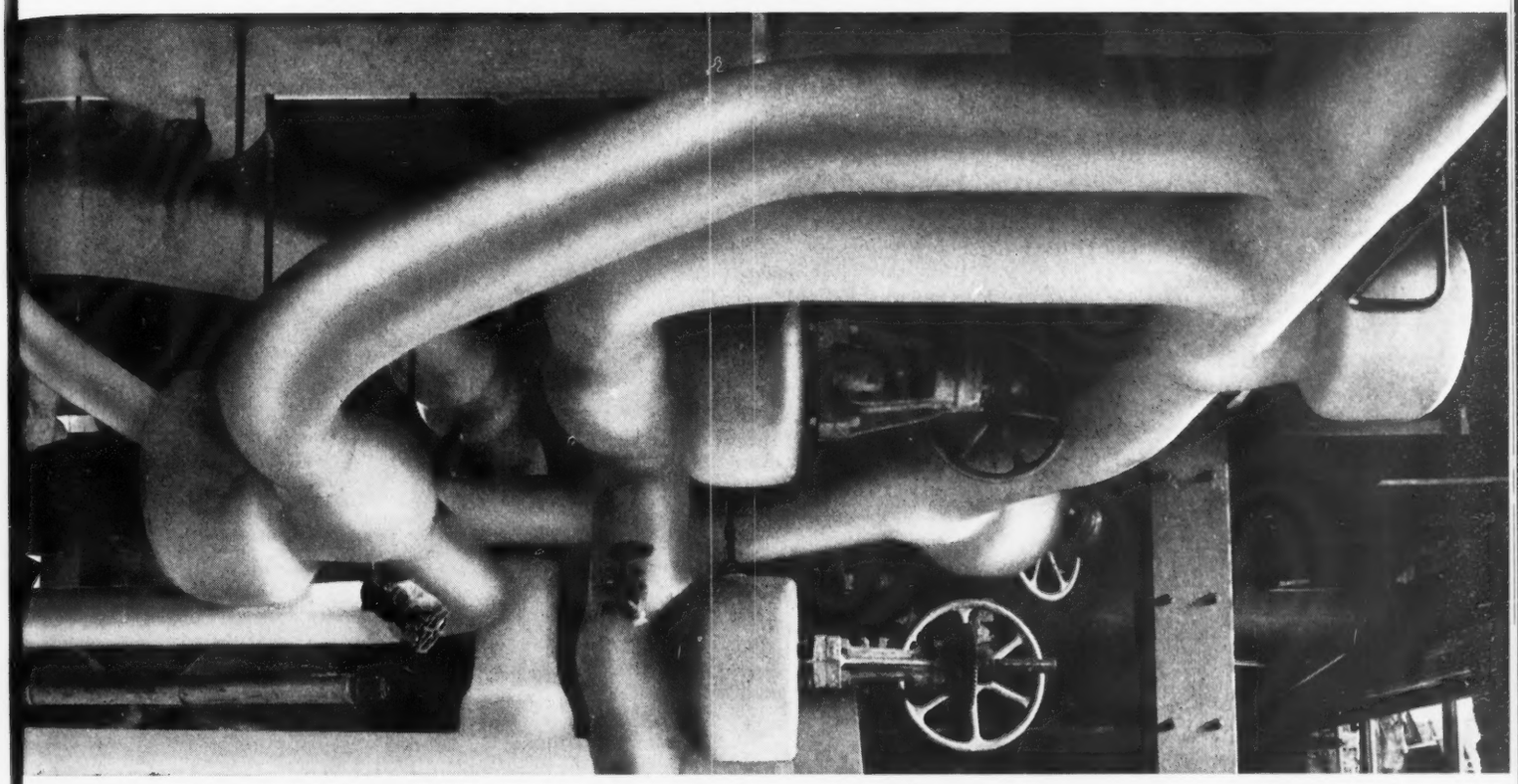


STANDARD UNIONS
Hot Forged From Solid Steel Bars

The forging process further refines the steel in Catawissa Unions and enables them to withstand years of shock and vibration. Seats, Steel to Steel, STAINLESS STEEL to Steel or Bronze to Steel are carefully hand ground, require no packing and are set on a 55° angle with a flat surface contacting a ball surface. This insures a perfect seal even though pipe is out of line . . . . Write for complete data and prices.

THE CENTRAL FORGING CO.
CATAWISSA, PENNA.

Prefabricated by PITTSBURGH PIPING



A good start for ANY piping system

BECAUSE there are so many factors entering into the correct and efficient fabrication of any piping system, it is highly essential that the work be done by a qualified company experienced in all phases of piping work.

The engineering department should be well versed in the practical as well as theoretical phases of piping in order to detail and layout the fabricated assemblies as efficiently and economically as possible. In the shop there must not only be equipment for precision bending, welding and machining, but also skilled mechanics who know how to fabricate and heat treat the many different metals used in today's piping systems. Field erection and stress relieving on the job, though greatly simplified by shop pre-fabrication, is a highly complex affair that requires men especially trained in this type of work. Maintaining the construction program, working without interfering with other subcontractors or station operating schedules is an important detail that calls for competent supervision of the field crews.

With a background of nearly 40 years' experience, Pittsburgh Piping KNOWS all these phases of modern piping practice. Whether you are contemplating an extension to your present system or the construction of a new plant, you can be certain that Pittsburgh Piping & Equipment Company can fabricate and erect it correctly and economically. Your nearest Pittsburgh Piping representative is listed below.

PITTSBURGH PIPING & EQUIPMENT CO., 10 FORTY-THIRD ST., PITTSBURGH, PA.

Woolworth Building, New York
Public Square Building, Cleveland
Occidental Building, Indianapolis
Liberty Life Building, Charlotte
Peoples Gas Building, Chicago
10 High Street, Boston
Union Guardian Building, Detroit
525 Market Street, San Francisco

Pittsburgh Piping

What have these 3 in common?

They can all be successfully handled in pumps and valves packed with Greene, Tweed Packings. There's an exactly suitable Greene, Tweed Packing for practically every fluid—including acids, alkalis, and solvents, as well as steam, water or air. Carried by leading mill supply houses.

FREE WORKING SAMPLE

If you are having trouble with packing on any service, that's your opportunity to give our packings a real test—without cost. Send us your name and address for free working sample, stating the size and service. We are sure of the outcome, because more than 90% of the engineers who have made similar tests have become permanent users. Our ABC chart, showing the correct packing for every service, will also be sent you.

Greene, Tweed & Co.
101 Park Ave., New York

PALCO for water · PELRO for solvents, oils
SUPER CUTNO for acids · CUTNO for alkalis

Made by the manufacturers of PALMETTO

Send the coupon for free sample

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Send free working sample of packing.....size,

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☐ Send free working sample of Palmetto Super-Sheat. Also ABC Packing Chart.

Name .....

Company .....

Address .....

Power Lines

(Continued from page 122)

Electric Co, died Jan 23, at Cooperstown, N.Y. He was well known throughout the east as an engineer. He supervised the design and construction of the Botocan hydro-electric plant at Manila, Philippine Islands, and also the design and construction of the Greenidge plant at Dresden, N. Y.

FRANK X PUND, vice-president of the D T Williams Valve Co, Cincinnati, O, died on January 21, 1941.

WILLIAM R LEWIS, retired superintendent of the Schoellkopf plant of the Niagara Falls Power Co, died January 31, at his home in Niagara Falls. A native of Wales, he came to the United States at the age of 19.

BAYARD P DEXTER, 56, president and treasurer of the Leavitt Machine Co, Orange, Mass., died recently following a short illness. He was graduated from Phillips Exeter academy and attended Cornell University before joining the Leavitt Machine Co, makers of valve-reseating equipment, in which his father had a large interest. His son, F A Dexter, will continue in the company.

EDWARD P HARRINGTON, 76, formerly plant engineer for the Turner Center Milk Co, prior to his retirement, died at his home in Melrose, Mass., Feb 3.

PERSONALS

EDWIN L DENNIS, chief combustion engineer, Coppus Engrg Corp, Worcester, Mass., since 1939, has been appointed to the faculty of Louisiana State University, Baton Rouge. Establishing his headquarters at Baton Rouge, Mr Dennis will assume his dual duties and will retain his connections with the Coppus organization.

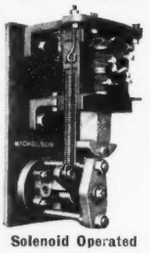
F M GARDNER is now affiliated with Cooper Bessemer Corp, in the diesel and gas engine sales dept. With his headquarters at the company's Mt Vernon, Ohio, offices, Mr Gardner's territory will include western Ohio, Indiana, Kentucky and Tennessee.

JAMES A POWELL, of Reading, Pa., will become associated with Stone & Webster Engrg Corp, on March 1. He will make his headquarters at 49 Federal St, Boston, Mass. Mr Powell is well known in engineering circles and

NICHOLSON

CONTROL VALVES FOR LONG PRESSURE-TIGHT SERVICE

Available in TWO, THREE, FOUR-WAY and Special Types for operating Air, Steam, Water or Oil Cylinders on pressures up to 5000 lbs. Made in five different metal combinations to cover all mediums handled. Non-corrosive metals are used in all vital parts. Gaskets and gland packing suitable for each specific service are used.



CATALOG No. 140 ON REQUEST

OTHER NICHOLSON PRODUCTS

Piston and Weight Operated Traps, Flexible Couplings, Expanding Mandrels, Arbor Presses, Compression Shaft Couplings, Steam Eliminators and Separators, Compressed Air Traps.

W. H. NICHOLSON & COMPANY
125 OREGON STREET
WILKES-BARRE PENNSYLVANIA, U.S.A.

Babbitt
Adjustable
SPROCKET RIM
with Chain Guide
MAKE YOUR
OVERHEAD VALVES SAFE
and EASY TO REACH —
CONTROL VALVES
FROM THE FLOOR
With Babbitt Sprocket Rims on your overhead valves you can control valves instantly from the floor. Far quicker and safer than climbing ladders.
Babbitt Rims are easily attached in a few minutes, are inexpensive and assure safe, positive and instantaneous overhead valve operation. Available for valves of every make or style. Write for details.
BABBITT STEAM SPECIALTY CO.
New Bedford Mass.

UNIBESTOS

BLOCKS — SHEETS and SECTIONAL PIPE COVERING

The Practical Insulation

Hard, smooth exterior. Resilient—hard to dent.
Accurately sized for snug fit on pipe. No shrinkage. No warping.
Precision cut sections insure tight joints without cement.
Tough, fibrous, porous interior. Felted structure permits stripping to fit couplings.
Unaffected by vibration. Undamaged by steam leaks. Dries out readily even after soaking in water.
Cuts down the usual losses through damage in shipping and handling.

OPERATING ENGINEERS will agree that anything around a plant that is breakable or easily damaged can often be more of a liability than an asset. To give plant men the kind of durability they want, many suppliers of equipment have conducted extensive development and product improvement programs. That the same sort of improvement could be achieved in the field of *high efficiency* heat insulation has been forcefully demonstrated by UNIBESTOS!

Unibestos is lower in thermal conductivity than the commonly used insulations and it has real durability. Cost, including installation, usually permits a saving. We will be pleased to mail you a sample of UNIBESTOS and literature. Write to UNION ASBESTOS AND RUBBER CO., 1811 S. 54th Avenue, Cicero, Ill.

UNIBESTOS 750. For temperatures up to 750° F. Standard 36" lengths of sectional insulation for all sizes of pipes and standard 36" x 36" sheets. Any thickness up to 5", except maximum of 2½" thickness on pipes 1½" dia., or smaller, and 4" max. thickness on 36" dia. pipe.

UNIBESTOS 1200. For temperatures up to 1200° F. Available in same standard sizes as UNIBESTOS 750. Get our tables of recommended thicknesses.

COMBINATION UNIBESTOS. Produced to order for any temperature limit between 750° F. and 1200° F. Information on request.

UNARCO

UNION ASBESTOS AND RUBBER CO.

Factories in Cicero, Illinois, and Paterson, New Jersey

CHICAGO NEW YORK SAN FRANCISCO

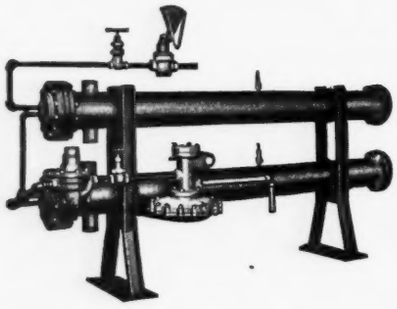
Contractor-Distributors in Principal Industrial Centers

Speed up
DEFENSE PRODUCTION
with
HENSZEY
CONTINUOUS BLOWDOWN

Heavy steam demands caused by increased production schedules make continuous plant operation imperative. Boilers operating at high loads *must* have the proper control of boiler water concentrations to operate efficiently, safely and without unnecessary shut downs.

The control of boiler water concentrations with a Henszey Continuous Blowdown system insures

- **CLEAN BOILERS**
- **CLEAN WATER**
- **CLEAN STEAM**



CLEAN BOILERS MEAN: No boiler scale • Less labor cleaning boilers • Lower fuel bill • Greater boiler capacity • Better circulation • Increased life for boilers • No tube burns • Longer period between shut downs.

CLEAN WATER MEANS: No priming • No foaming • No caustic embrittlement • Lower fuel bills • Steady water level • Greater boiler capacity • No clogging of dry pipe • Much less corrosion.

CLEAN STEAM MEANS: Packings last longer • Less cylinder oil consumption • Less wear on rods and cylinders • Less turbine blade erosion • No coating of turbine nozzles and blades • No sticking of reducing valves, non-return valves, traps, etc. • More superheat • Cleaner condenser tubes • Less piston and valve leakage • Less steam consumption • No superheater burnouts.

The Henszey System does all this Continuously, Automatically, and *Without Heat Loss!*

Investigate at once!

HENSZEY COMPANY
Dept. D3 Watertown, Wis.

HENSZEY

has an outstanding reputation in the mechanical-engineering and power-plant field. He has, for many years, been associated with the E M Gilbert Engineering Corp, from which he recently resigned as vice-president and chief engineer.

JOHN ASHBAUGH, formerly engineering manager at East Springfield Works, Westinghouse Electric & Mfg Co, has been appointed assistant manager of Manufacturing and Engineering for Merchandising Div. He will maintain headquarters in East Springfield, but will be responsible for work at both Mansfield and East Springfield. He joined the Westinghouse Merchandising Div in 1931, and a year later was named manager of engineering at the East Springfield works.

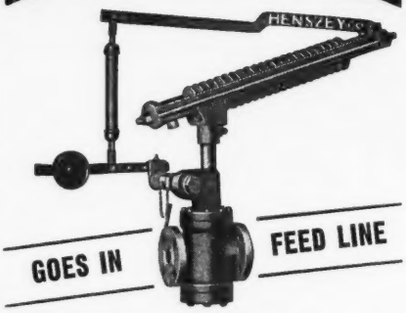
HAROLD F FALK has been promoted to position of general superintendent of the Falk Corp, Milwaukee, Wis. Following his graduation from the University of Wisconsin, Mr Falk became associated with the Falk Corp, and rose to position of superintendent of the Welding Dept, where he remained until 1936. He was placed in charge of shop production and schedules in 1937, working in that capacity until 1940, when he was made production manager.

F A MITCHELL, vice-president of the Virginia Public Service Co, at Alexandria, is to become head of company's operations in the Newport News, Va., area, replacing N E Drexler, formerly vice-president, who resigned to become president of the Tidewater Power Co, Wilmington, N. C. Mr Mitchell has been with the organization as operating vice-president since 1937.

DAVID A COWHIG has been named general manager of Wilkening Mfg Co, Philadelphia. He has been with the organization for nearly 13 years, most recently as assistant treasurer and comptroller. He is a graduate of the University of Pennsylvania. W A Kirkpatrick, who has been advertising manager for the past five years, will be in direct charge of all advertising and sales-promotion activities of the company.

As a symbol of his 60 years of service with the Gardner-Denver Co, J W GARDNER, chairman of the executive committee of the Board of Directors of the company, was presented with a tiny gold, diamond-set model of a steam governor. He first joined what was then the Gardner Governor Co at the age of 17, starting as an apprentice machinist. His service includes nearly 30 years as

HENSZEY
BOILER FEED REGULATORS



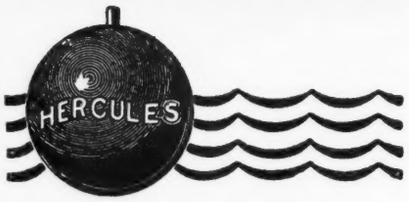
The Henszey Boiler Feed Regulator controls boiler water levels continuously and accurately under *all* load conditions!

These simple, compact, self-contained units go right in the feed line and require no additional structural support. They are as easy to install as a simple gate or globe valve. Once installed and set for operation no further attention is necessary — nothing to get out of order — nothing to reset.

Send for latest Bulletin containing full details.

HENSZEY COMPANY
Dept. D3—Watertown, Wis.

HERCULES
Seamless Copper
FLOATS



GUARANTEED TO STAND UP!

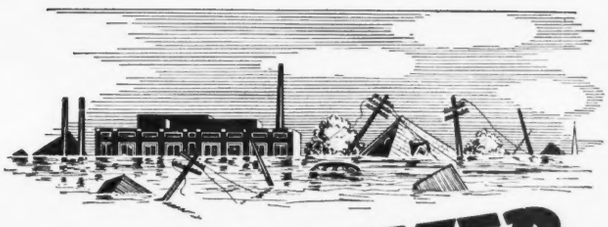
Every Hercules Float carries our guarantee to stand up under 350 lbs. working pressure and 500 degrees temperature.

Fabricated of seamless copper under our special spinning process. Hercules Floats are uniform in thickness and high in mechanical strength.

You can depend on Hercules for floats—in standard shapes up to 10 in. and in special types to your specifications—to give long, dependable, economical service.

Insure care-free maintenance of water level in your heaters, tanks, reservoirs and other equipment by specifying "HERCULES."

HERCULES FLOAT WORKS
200 Franklin St.
SPRINGFIELD, MASS.



UNDER WATER FOR DAYS—

THIS K&M INSULATION IS AS EFFICIENT AS EVER

Showing the mud-stained K&M insulation, immediately after the flood had subsided. Not a pretty picture in itself, but one which testifies to the money-saving durability of this K&M insulation—a feature of vital interest to users. This is an actual case, from the Keasbey & Mattison files. Material was applied by Louisville Insulating & Supply Co., approved K&M Distributor.

Seven feet of muddy water filled this boiler room when flood waters engulfed it. Not for days did the flood subside . . . but when it did, the mud-stained Keasbey & Mattison "Featherweight" 85% Magnesia which insulated this plant's steam boilers, after being washed and dried, picked up the job of saving heat and fuel just as if nothing had happened!

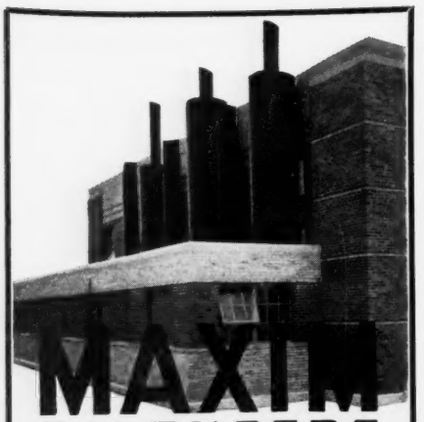
60,000 square feet of K&M "Featherweight," two inches thick, had helped to keep these boilers at their normal high operating temperature during previous years. Following the flood, the boiler operating efficiency was as high as ever. And when new, larger boilers were recently installed, it is not surprising that K&M "Featherweight" 85% Magnesia once again was the insulation selected.

This incident shows that K&M "Featherweight" 85% Magnesia is not only one of the most efficient heat insulators ever developed for temperatures up to 600°F., but that it is also one of the most durable. Like all K&M asbestos and magnesia products, it is the result of nearly seventy years' specialized experience in building superior insulation materials for American industry.

Keasbey & Mattison engineers, working with K&M Distributors strategically located throughout the country, can point the way to real savings in your plant, too. Write Dept. 11 for full details.

KEASBEY & MATTISON

COMPANY, AMBLER, PENNSYLVANIA



MAXIM
SILENCERS

COVER THE FIELD
with STANDARD *models*

With Maxims you have a complete line of silencing equipment to work with . . . standard silencers that give you *what you need for your particular installation* . . . Here we show only two of many situations that can be met successfully with standard Maxim Silencers.

Above:

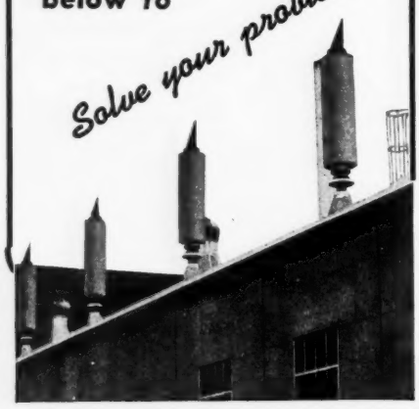
Illustration above shows municipal power plant located in center of a small western town where the need was for the highest degree of exhaust silencing obtainable. Solution: Maxim MU2 Silencers.

Below:

Illustration below shows a gasoline refinery . . . danger of explosion in exhaust lines of natural gas engines. Solution: Maxim Heavy Duty MUX1 Silencers.

Use Coupon below to

Solve your problem



THE MAXIM SILENCER COMPANY
92 Homestead Ave., Hartford, Conn.

Please send details on your ☐ Engine exhaust ☐ Steam ☐ Compressor Silencers.

Name .....

Company .....

Address .....

City .....

State .....

president, and in more recent years, a position on the executive committee.

M P Robinson, Robinson Filter Co, has joined Worthington Pump & Machinery Corp to take charge of the newly organized Water-Purification Equipment Division. Prior to establishment of his own water-purification company in 1937, he had, for 17 years, been eastern representative at the International Filter Co, Chicago.

M C Bellamy, sales engineer of the Seattle, Wash., office of Timken Roller Bearing Co, since 1934, has been made district manager of the Industrial Bearing and Steel Sales for the Seattle territory. He joined the company in 1928, worked in the engineering department for two years, and was appointed sales engineer in 1930.

F E Fairman, Jr, has been appointed assistant manager of the Switchgear Div, Central Station Dept, General Electric Co, Philadelphia. After spending some time with the U. S. Navy, Mr Fairman resigned and joined the company as switchgear engineer in 1923 at the Baltimore Works. He was transferred to Pittsburgh in 1927, three years later becoming an industrial salesman handling steel mills. He returned to the Switchgear Div in 1933, became manager of the Equipment section in 1939.

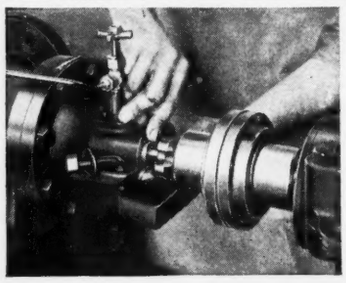
Harry J Schultz has been appointed central regional manager of the Construction Equipment Div, Worthington Pump & Machinery Corp. He will make his headquarters at Worthington's Chicago office, 400 West Madison St.

James Orr, superintendent of power for Hartford Electric Light Co since 1922, has been appointed consulting engineer of that utility. Mr Orr was born in Scotland, coming to America about 1893. He was connected with Stone & Webster, Inc, before going to Hartford.

Dwight Douglass, assistant superintendent, has been appointed superintendent of power for Hartford Electric Co, succeeding James Orr. Mr Douglass was graduated from Rensselaer Polytechnic Institute in 1920, and has been in the Manufacturing Div of the Hartford Co throughout his career.

William C Yates, since 1937 manager of the Control and Renewal Parts Dept, General Electric Co, has been appointed assistant manager in the Industrial Dept. He will continue to have charge of the first-named division.

L E Osborne, manager of manufacturing and engineering for Westinghouse Merchandising Div, has been



Only 1 STUFFING BOX and that EASILY PACKED

The stuffing box of the
De Laval-IMO Oil Pump

is under suction pressure and is directly accessible. There are neither valves nor gears and only three moving parts. Oil of any viscosity is delivered against any pressure without vibration, shock or pulsation, and the pump operates at standard motor or turbine speeds.

Write for Catalog I-73.

IMO
I MOVE OIL

IMO PUMP DIVISION
of the
De Laval Steam Turbine Co.
Trenton, N. J.

"STANDCO" PILLOW BLOCKS

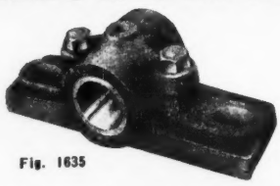


Fig. 1635

Combining clamp block and pillow block requirements in one type, the "Standco" shown above is sturdily built and is offered in a wide range of sizes. Babbitted bearing surfaces are finished beautifully smooth, both faces machined. It can be depended on for long, trouble-free service.

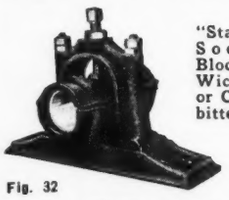


Fig. 32

"Standco" Ball and Socket Pillow Block, Ring or Wick Oiling, Plain or Collar End Babbitted Bearings.

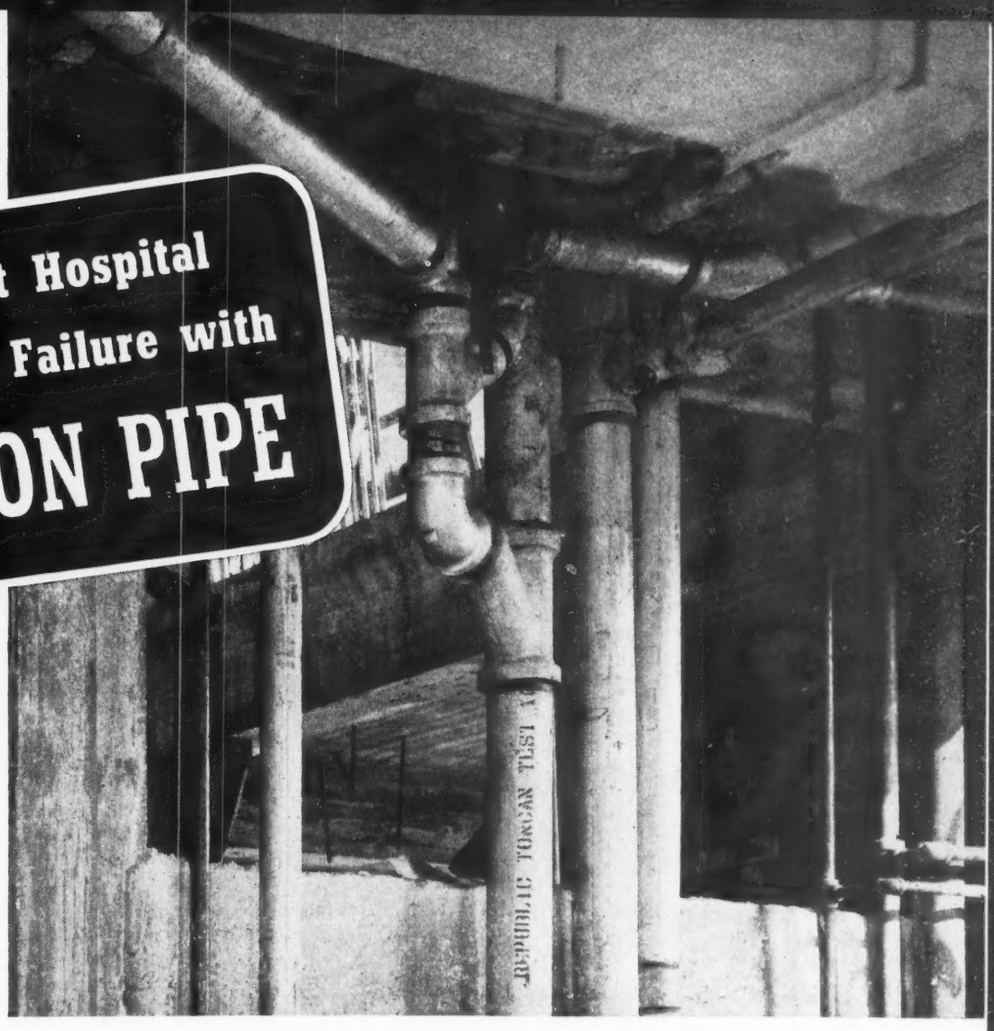
Write for Bulletin

STANDARD PRESSED STEEL CO.
JENKINTOWN, PENNA

Boston
Detroit
Indianapolis
Box 577
Chicago
St. Louis
San Francisco

Two carloads of Toncan Iron Pipe were used in the Delaware Hospital, Wilmington, Delaware, for hot and cold water, waste and vent lines. Republic steel pipe was used for heating lines and Republic steel sheets for ducts.

Delaware's Newest Hospital Guards Against Pipe Failure with TONCAN IRON PIPE



The Power Production Industry today—like all American industry—is faced with its greatest challenge in history. It must carry out its share of a gigantic National Defense program and at the same time satisfy the normal needs of a prosperous nation. To do this requires steel products in unprecedented quantities.

Republic Steel, during the decade of its existence, has enlarged its facilities, improved its equipment and carefully trained its organization of men who know steel.

Today, Republic's men in the mills are proud of the new production records they are setting. In the offices, experienced men are doing their level best to see that the steel needs of the nation are served. Republic is doing its full part in supplying ***steel—first line of national defense.***

R. J. Wysor
PRESIDENT

You will find Toncan* Iron protecting the plumbing and heating systems of many of the country's major buildings—fighting rust and saving money and trouble for building owners. And you'll find, as so many other architects and engineers have, that its cost—higher than that of ordinary pipe—is low in the light of the many additional trouble-free years of service it delivers.

Read all about this alloy iron pipe in Bulletin 333—how it is made—why it saves money—installations where it has been in service for years. Ask for a copy or see Sweet's 27/3.

REPUBLIC STEEL CORPORATION
General Offices: Cleveland, Ohio

BERGER MANUFACTURING DIVISION • CULVERT DIVISION • NILES STEEL PRODUCTS DIVISION
STEEL AND TUBES DIVISION • UNION DRAWN STEEL DIVISION • TRUSCON STEEL COMPANY

*Reg. U. S. Pat. Off.

REPUBLIC TONCAN IRON

An alloy of refined open-hearth iron, copper and molybdenum—*that grows old slowly*

In More Than 12,000 Plants

COCHRANE

MULTIPORT RELIEF VALVE

Cochrane Motor Operated Multiport Back Pressure Relief Valve with Automatic Control

The economy of being able to adjust pressure easily according to heating demands is readily apparent—particularly in changing from load periods to off-load, and vice versa.

Cochrane Multiport Back Pressure Relief Valve makes this a very simple operation, either by hand wheel, chain wheel, or automatic control—besides giving you the added protection of its multiport principle, insuring against over pressure and sticking, jamming, or freezing of the valve disc.

Successful operation in more than 12,000 steam plants is ample proof of their reliability. Call your Cochrane representative or write for further details.

COCHRANE Exhaust Head

Designed to separate condensate and oil from steam discharged to atmosphere and thereby prevent raining of water and oily condensate on the roof, Cochrane Exhaust Heads incorporate a highly efficient free-flowing baffle type construction and an exceptionally large port area which minimizes back pressure. Write for further details.

COCHRANE CORPORATION
3106 N. 17th Street, Philadelphia, Pa.

COCHRANE

Cochrane Corp., 3106 N. 17th St., Phila., Pa.
Please send me complete information on Cochrane Multiport Relief Valve and Cochrane Exhaust Head.
Name_____
Firm_____
Address_____
City_____ State_____

granted a leave of absence to join the staff of the Defense Commission, in Washington, D. C. Mr Osborne, a veteran of more than 30 years experience with Westinghouse, will be assigned to the staff of the Defense Commission's Office of Production Management. His acceptance of the defense post is in response to a request by William S Knudsen, defense chief.

L A MULLEN has been made manager of sales of tubular products for Pittsburgh Steel Co. Mr Mullen has been associated with Pittsburgh Steel since January, 1938, first as assistant district sales manager at New York, later as district sales manager at Chicago, and for the past year as assistant manager of sales in Pittsburgh.

PERCY JENKINS, who was associated with Wickwire Spencer Steel Co for more than 15 years, has been appointed manager of the Boston branch of John A Roebling's Sons Co. During the time he was with Wickwire Spencer, he held various positions, including that of assistant manager of sales, manager of eastern district, and manager of sales. His office will be located at 51 Sleeper St, Boston, Mass.

JAMES F TOWERS, executive vice-president, Ford, Bacon & Davis, Inc, has been appointed assistant director in charge of Administration of the Division of Priorities, Office of Production Management, Washington, D. C. by E R Stettinius, Jr. During his absence from his office, his duties will be assumed by W E Reynolds and H E Whitaker, vice-president and chief engineer.

THOMAS J JOHNSON, associated with the New Industries Div, Alabama Power Co, for a number of years, has been elected vice-president. He is a native of Ozark, Ala., and a graduate of the Engineering School, University of Alabama.

W F RYAN, mechanical engineer, has been appointed assistant chief mechanical engineer of Stone & Webster Engrg Corp, Boston, and A B WILLIAMS, assistant engineering manager, has been named consulting engineer.

FRANK W WILKES, operating vice-president and member of the board of the Arkansas Power & Light Co, resigned recently to become assistant to the president and general manager of Southwestern Gas & Electric Co.

P S DICKEY has been named special consultant in problems of marine boiler control of Bailey Meter Co. Mr Dickey heads all research activity of the company.

Want an Easier Way to Clean Your Floors?

Many plants will tell you that successful, low-cost Oakite materials make floor cleaning an EASY maintenance job . . . and help you save money, too!

For due to their rapid, fast-working emulsifying action, Oakite materials thoroughly and speedily soften caked-on grease, oil, grime and dirt, so that a mop-up rinse removes every trace of deposits. Floors are again clean. Quick-drying, too . . . no slippery film . . . safe to walk on. Besides, cost is amazingly low due to the exceedingly small amounts of material used!

WRITE FOR DETAILS

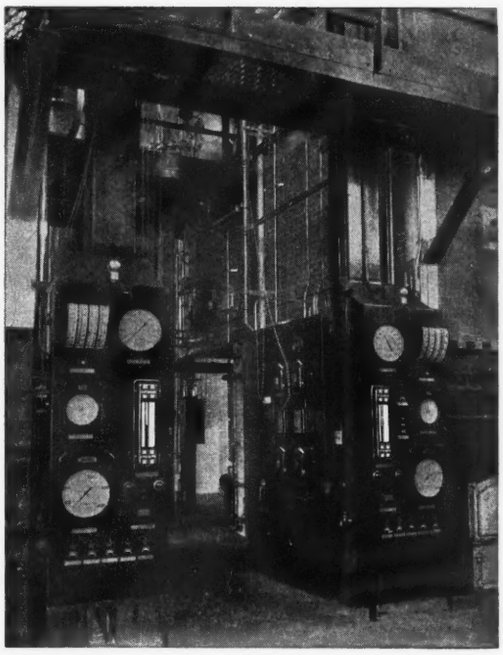
Let us give you complete details. Also ask for interesting booklets and data sheets giving money-saving methods for such other maintenance work as cleaning air filters, stripping transformers, cleaning and de-scaling Diesel cooling systems, surface condensers, heat exchangers, etc. Since there is no obligation, won't you write us today?

OAKITE PRODUCTS, INC.
23 Thames Street, New York, N. Y.
Representatives in All Principal Cities of the United States and Canada.

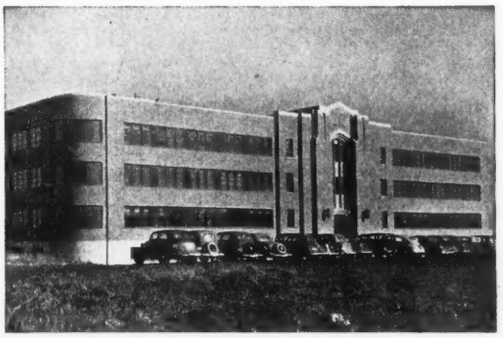
OAKITE *Certified cleaning*
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

This is No Time to take Chances on *Power Failure*

Safeguard boiler water levels with **Reliance** ALARM and EYE-HYE



The Reliance Safety Team fills the important function of checking water levels in the new Regional Laboratory of the U. S. Department of Agriculture, at Wyndmoor, near Philadelphia. No. 5 Reliance High and Low ALARM Columns with Reliance Tiltview Gages and Reliance Weighted Gage Cocks are on the three boilers; Reliance EYE-HYEs No. E-13 (shown above on panels) give quick easy water level readings at eye level. Other Laboratories located at Albany, California; Peoria, Illinois, and Beltsville, Maryland, are equipped with EYE-HYEs for dual water level protection.



Positive Supervision of water levels prevents costly accidents — shut downs and loss of production

YOU men who shoulder the responsibility in the power plant will agree that every means of guarding against power failure is justified these days. Make sure your boiler water levels are checked unfailingly. The Reliance Safety Team gives both SOUND and SIGHT supervision — *dependable* check against dangerous or inefficient water levels • Up on the boiler drum the Reliance ALARM sounds instant warning when water levels go too high or too low — by shrill whistle or by as many electric signals as needed to reach attendants, wherever they may be • EYE-HYE carries the true water level reading, in a brilliantly illuminated green indicator, to men on the boiler room floor. Saves time — induces more frequent reading • Don't take chances on *power failure.* For absence of concern over water levels, make doubly sure with the Reliance ALARM and EYE-HYE. *Write for free ALARM and EYE-HYE bulletins.*

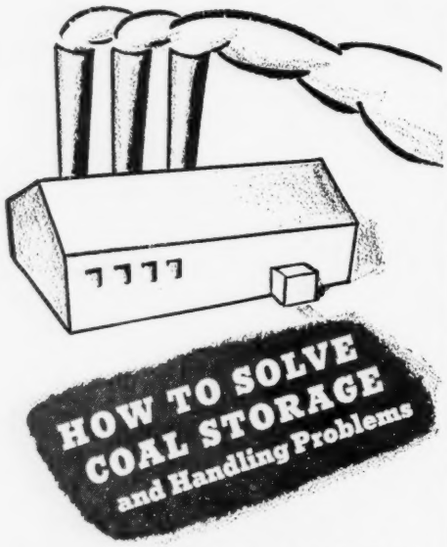
THE RELIANCE GAUGE COLUMN CO.

5902 Carnegie Ave., Cleveland, Ohio

TRADE MARK REG. IN U.S. PAT. OFF.

Reliance

Boiler Safety Devices since 1884



use LeTOURNEAU CARRYALL SCRAPERS

Buy and Store at Low Summer Prices—Build up your coal reserves in summer when prices are low . . . when water routes are open and rail facilities good.

Eliminate Fire Hazards—store without fear of fire hazards—LeTourneau Carryall Scrapers enable you to store coal in thin, even, horizontal layers with fines and coarse thoroly mixed. Weight of the unit traveling over coal closely packs pile, eliminates flues and thus prevents spontaneous combustion.

Cut Handling Costs—You can load directly from rail or dockside . . . haul and spread 25 to 200 tons hourly on storage pile, depending on Carryall size and length of haul.

Reclaiming Made Easy—Same Carryall that stores the coal is used to reclaim it from the storage pile, thus you eliminate extra handling equipment.

This method has been thoroly proven by 3 years of use by some of the country's largest coal users. Investigate its money-saving possibilities for your plant. Ask your LeTourneau-"Caterpillar" dealer for further details . . . or write TODAY for colorful, illustrated booklet. Address Dept. 3P.

LeTourneau Carryall picking up coal from dockside.

LETOURNEAU
PEORIA, ILLINOIS • STOCKTON, CALIFORNIA

BUSINESS ITEMS

WHITING CORP announces opening of district sales office in Philadelphia, Pa., at Room 838, Broad St Station. The office will be in charge of L D Reed. Mr Reed has been with the company for 26 years, both as an engineer and salesman.

LUNKENHEIMER CO, Cincinnati, Ohio, announces that Harry A Burdorf and Frank P Rhame, vice-presidents, were elected to the board of directors recently. Burdorf has been with the company since 1905, is vice-president in charge of sales, and Rhame, who has been with the Lunkenheimer since 1919, is vice-president of sales engineering.

MIDWEST STOKER ASSOCIATION, at its annual meeting in Chicago recently, elected officers for 1941. They are Mount Burns, manager, Chicago Retail Stoker Div, Link-Belt Co, president; E M May, Chicago branch manager, Combustioneer Div, vice-president; and E W Jones, office manager, Iron Fireman Mfg Co, secretary-treasurer.

WESTINGHOUSE ELECTRIC & MFG CO, announces election of four executives as vice-presidents. They are Bonnell W Clark, now president of Westinghouse Supply Co, a subsidiary; R A McCarty, manager of the Steam Div, Philadelphia; Frank D Newbury, Pittsburgh, manager, Emergency Products Div; and A C Streamer, general manager of the East Pittsburgh Div. All new vice-presidents have been associated with Westinghouse for many years.

SARCO CO, 183 Madison Ave, New York, N. Y., announces removal of main offices to 475 Fifth Ave, New York, effective March 1.

LUDLOW VALVE MFG CO, Troy, N. Y., announces several executive changes. Alfred W Thompson was elected president, treasurer and general manager, succeeding L W Houston, who was elected chairman of the Board of Directors. Joseph E Egolf, with the company for the past 50 years, and treasurer for the past eight, retired from active service at the close of 1940. Other new officers elected were Harry Hoffman, New York, vice-president, and John Ireland, Troy, assistant secretary and assistant treasurer. Robert Bischoff, formerly associated with the Koppers Co, has been appointed sales manager.

INDUSTRIAL UNIT HEATER ASSN, at its annual meeting in Cleveland recently, elected A B Donkersley, president; C C Cheyney, vice-president; and

How these

FEDDERS DATA BOOKS

Simplify Selection of

HEATING COILS
UNIT HEATERS
COOLING COILS
AIR CONDITIONING UNITS
COMFORT COOLING UNIT COOLERS

You will find that their working data has been compiled, charted, arranged and indexed to be accurate, practical, readable and convenient to use.

You will automatically sense that the products which they cover are as well designed as the books themselves.

Fedders heating and air conditioning products meet a wide variety of industrial and commercial requirements.

Write for your Fedders Data Books NOW!

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Air Conditioning Division
63 Tonawanda Street Buffalo, N. Y.
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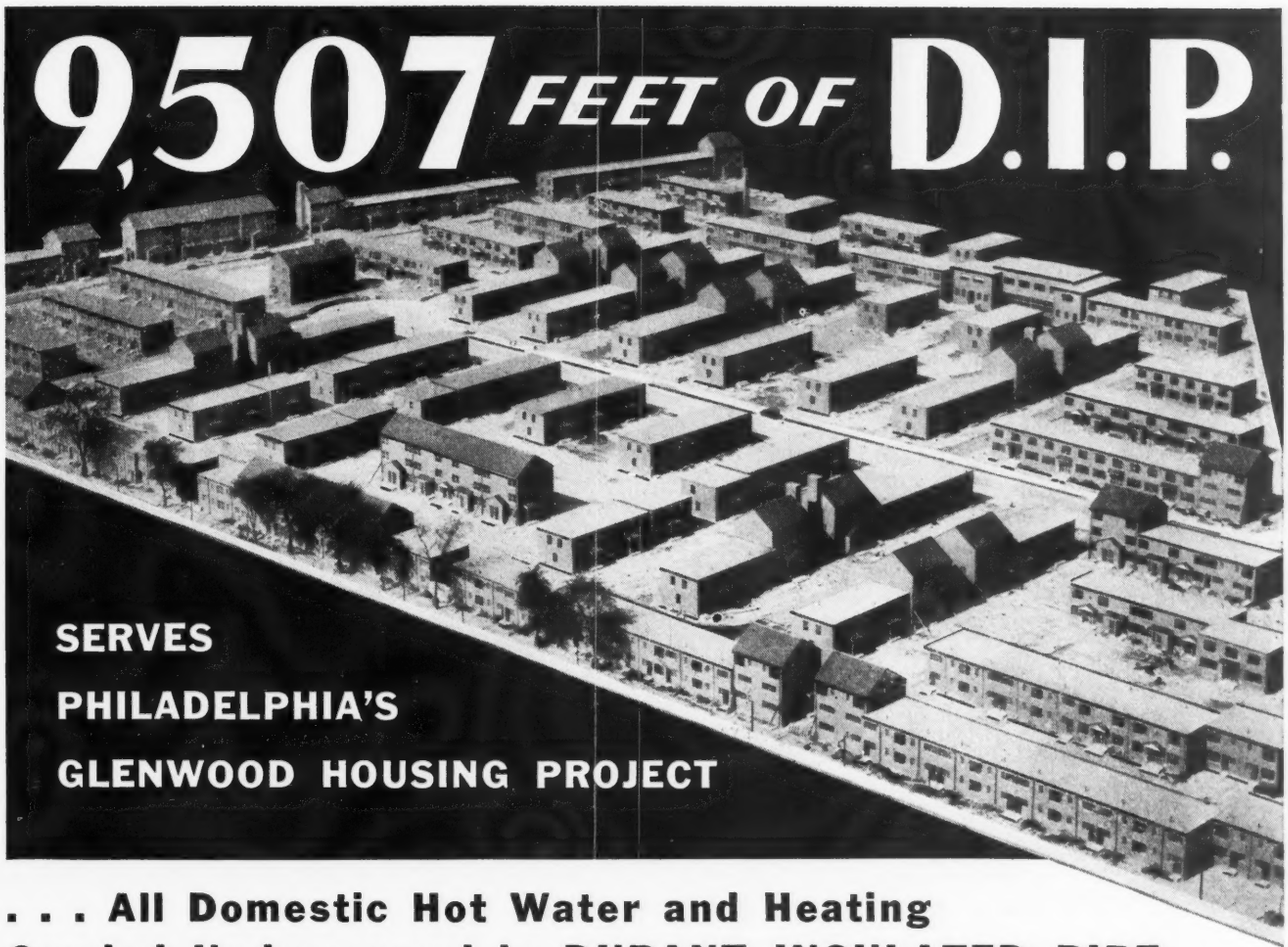

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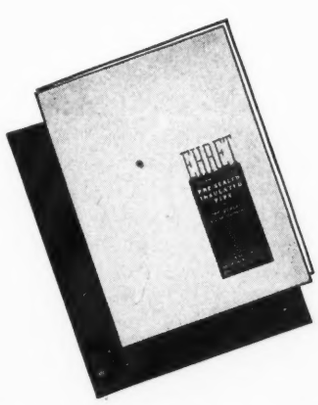
The underground domestic hot water and heating distribution system in this modern housing development consists entirely of Ehret's Durant Insulated Pipe. The various lines, ranging in size from ¾″ up to 4″, were laid side by side, four lines to a trench, and the minimum distance from the top of the pipe to the ground surface is only 30″.

In making this installation, back-fill followed directly after the pipes were laid. Although driveways which run throughout the development cross the piping in a dozen different places, no special protection against vehicular loads or impact was required. Durant Insulated Pipe is designed to stand up under such service.

Because of the simplicity, dependability and ease with which it can be installed, Ehret's Durant Insulated Pipe is ideal for underground use. Engineers, architects and industry are turning, more and more, to D. I. P. as the most economical and most satisfactory system for the protection of underground steam and hot water lines.



Write us today for this Ehret booklet which gives full details on the D. I. P. system.

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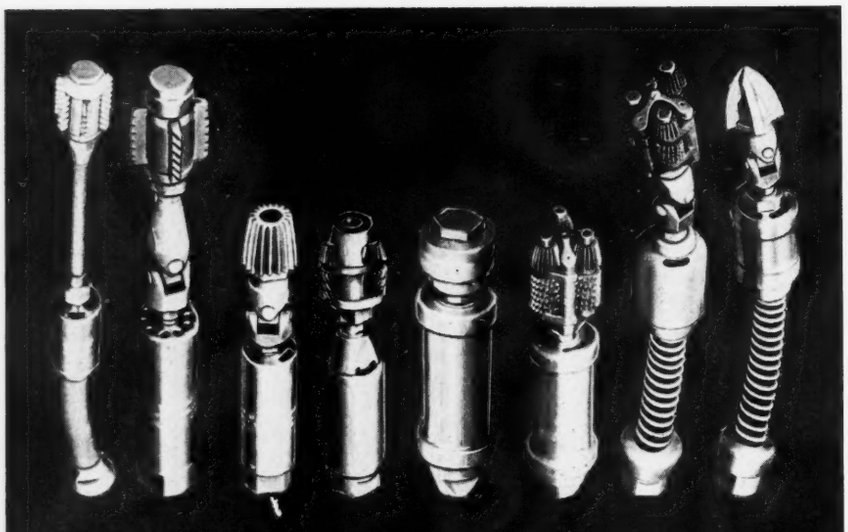


REDUCE TUBE CLEANING "BOTTLENECKS" IN DEFENSE INDUSTRY POWER PLANTS

With hundreds of defense industries working 24 hours a day power plant capacities are taxed as never before. Clean tubes in boilers, superheaters, economizers, etc. are essential to maximum power production but long shutdowns for tube cleaning can easily disrupt plant production schedules.

In many of these power plants maximum power output is maintained by the use of Wilson tube cleaning equipment which cleans ferrous and non-ferrous tubes and pipes—straight or curved—of large or small diameter—quickly, thoroughly and economically.

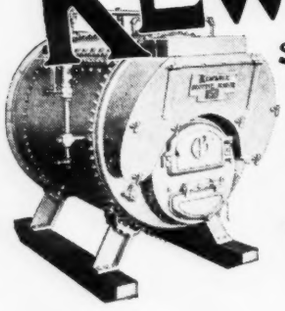
Let us show you how Wilson tube cleaning equipment can aid *your* plant in maintaining production schedules. Write for the name of our representative nearest to you or send for a copy of our new thirty-six page catalog fully describing and illustrating the complete line of Wilson tube cleaning equipment.

THOMAS C. WILSON, Inc.
PIPE AND TUBE CLEANERS EXCLUSIVELY
47-28 37th Street Long Island City, N. Y.

HIGH PRESSURE STEAM AT LOW COST!

KEWANEE

SCOTTIE JUNIOR BOILER



Five sizes . . . conveniently compact, yet easily accessible . . . most economical in first and operating costs. A fuel saver. May be purchased on easy payments under FHA terms thru our Finance Corp.

Ask our nearest office, or write for Catalog K111

KEWANEE BOILER CORPORATION
KEWANEE, ILLINOIS
Branches in 64 Cities—Eastern District Office: 37 West 39th St., New York City

L O Monroe, secretary for the coming year. The association has been actively engaged in research and study for the development of standard methods of testing hot-water unit heaters.

Okonite Co announces opening of company's 16th district office at 1212 Comer Bldg, Birmingham, Ala. Dewey A White, connected with the Okonite organization for 17 years, has been appointed manager of the new office. His south central territory includes the states of Tennessee, Alabama, Mississippi, and Louisiana.

Membership of the board of directors of Sterling Engine Co was increased recently from seven to ten. New members are Lawrence D Bell, president, Bell Aircraft Corp; William J. Connors, president and publisher of Buffalo, N. Y. *Courier-Express*; and Reginald B Taylor, Buffalo financier and industrialist.

Reliance Electric & Engineering Co, Cleveland, Ohio, is opening a sales office in Minneapolis, Minn., with Elwood H Koontz as district manager. Mr Koontz goes to his new responsibilities in Minneapolis from Reliance's Philadelphia office, where he has been a member of the sales engineering staff for the past three years.

Tom H Pike, Jr, West Coast district manager for Tube-Turns, Inc, Louisville, Ky., has established permanent offices in Los Angeles at 210 West 7th St. The entire west coast and territory inland as far as Salt Lake City will be serviced from the new office. John C Chaffe has been appointed district manager of the Philadelphia office, which has been moved from the Lafayette Bldg, to Broad St Station Bldg.

Diamond Alkali Co of Texas was incorporated recently to manufacture and distribute alkalis and other chemicals in Texas. The new company has taken over the Gulf Coast Chemical Co, and will continue to operate the business as a division.

Universal Gear Corp, Indianapolis, Ind., announces appointment of Hubert Kaub, Denver, Colo., as representative in Colorado and Wyoming.

Armstrong Cork Co, Lancaster, Pa., announces change in brand names for various firebrick: N-16, light-duty brick, temperatures to 1600 F, becomes A-16, identified by distinctive red-brown color. N-20, light-duty brick, temperatures to 2000 F, will be known as A-20, identified by blue color spot stamped on the end. A-25, light duty use, temperatures to 2500 F, remains

Fig. 531-P Full Plug Type Bronze Globe Valve
—for severe throttling service
of 350 lb. steam

Low maintenance cost

WITH THIS 500 BRINELL FULL PLUG VALVE ON AUXILIARY STEAM LINES • DESIGNED TO HANDLE SEVERE THROTTLING SERVICES

550 Degree Steam at 350 pounds is hard on ordinary valves and particularly so when throttling is constant.

—Seats become wire drawn—Stem threads gall and wear
—Bronze bodies distort

THE 531-P IS NO ORDINARY VALVE.... SEATS AND DISC are of Stainless Steel of 500 Brinell Hardness. They will resist wire drawing to the last.... STEMS are of High Strength Rolled Naval Bronze, highly wear-resistant under the absence of all lubrication.... PRESSURE CONTAINING PARTS are of the best grade of temperature resisting bronze which can be cast.... The valve, with these integrated parts, will take it and give you minimum operating costs which are so important to you today.

READING-PRATT & CADY
READING, PENNSYLVANIA

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READING
CAST STEEL
VALVES & FITTINGS

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BRASS & IRON VALVES

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VALVE AND
ENGINEERING
SPECIALTIES

A Division of AMERICAN CHAIN & CABLE COMPANY, INC.

AIR WHERE YOU NEED IT

·QUICKLY·EASILY·

At minimum cost

DIRECT MOTOR DRIVE

Our 16 page engineering bulletin 3907 gives complete details and specifications. Write for your copy today.

SCHRAMM Stationary Air Compressors provide the means of supplying compressed air service right where it's needed for maximum convenience and use.

SCHRAMM, INC., WEST CHESTER • PA.

SCHRAMM Air Compressors

ALL THE HORSE POWER GOES THROUGH THE COUPLING

Ajax graphite-bronze rubber bushed flexible couplings give positive drive . . . protection against misalignment . . . free end float . . . no noise, no backlash . . . no lubrication worries. Write for Catalog.

AJAX
FLEXIBLE COUPLING CO.
132 English St., Westfield, N. Y.

unchanged, but is identified by orange color spot. EF-23, heavy-duty brick, temperatures to 2300 F, becomes A-23, identified by green color spot. EF-26, temperatures to 2600 F, on the hot face, is changed to A-26, identified by red color spot. Changes have been made solely for simplification purposes, with no change in formulation or method of manufacture of any of the above five brands.

Corrosion Prevention in Steel-Tank Rectifiers

THE FIRST MERCURY-ARC RECTIFIERS used glass vacuum chambers, which limited their physical size and electrical capacity. Efforts to increase their output led to the development of water-cooled steel-tank vacuum chambers. The cooling water used in these units caused serious corrosion problems. Analysis indicated that pitting corrosion caused the greatest damage.

According to Emil J Remscheid, in a paper presented before the Midwinter Convention of the American Institute of Electrical Engineers, the first efforts to solve the corrosion problem were directed toward finding a protective coating to isolate the steel tanks from the cooling water.

Asphaltum, metallic and metallic-oxide paints recommended for their corrosive preventive merits were studied. Varnishes and various lacquers were investigated. The corrosion-resisting properties of sprayed molten metals and their combinations were likewise investigated. Both air-drying and baked vitreous enamel applied to iron surfaces were given vigorous tests. These tests revealed that the binder in many of the air-drying applications would dissolve in warm water, while others would dry sufficiently hard to permit corrosion to develop.

Sprayed Metal Unsatisfactory

It was also found that sprayed metal would not make a sufficiently homogenous surface to prevent water from reaching the iron. Similarly, it was discovered that metals near the alkali end of the electromotive-force series would not long withstand the solvent action of water. Therefore, the effective life of metals of this nature would depend on the thickness of the coating.

Enameled surfaces on iron were found not sufficiently homogeneous to retard electrolytic corrosion. Vitreous enamel on rectifier surfaces was found very detrimental because any microscopic hole or crack in the enamel surface would take the total electrolytic current from the section and thus in a

This remarkable insulating cement is lastingly effective

EAGLE SUPER "66" RETAINS FULL EFFICIENCY YEAR AFTER YEAR BECAUSE IT IS CHEMICALLY AND PHYSICALLY STABLE

Why are more and more industrial and power plants insulating large heat producing and heat transmitting equipment with Eagle Super "66"?

That's easy to explain . . .

1. Low-cost installation. This unique plastic insulation is quickly and easily applied with a trowel. Tests show extremely high *dry* coverage—50-55 sq. ft. per 100 lbs.

2. Top efficiency. Eagle Super "66" is composed of small mineral wool pellets. These pellets have a "springy ball" structure—they do not crush down or flatten when applied to the job. Maximum heat savings are assured for a full range of temperatures—as high as 1800° F.

3. No deterioration. Because Eagle Super "66" is chemically and physically stable, it loses none of its efficiency during service. It is as effective the tenth year as it is the first month. It sticks on like glue—withstands normal contraction and expansion of heated surfaces without cracking. Does not cause or accelerate corrosion, even when wet.

4. Fully reclaimable. Eagle Super "66" can be removed, re-mixed and re-applied when used at temperatures below 1200° F. Repair work on equipment is facilitated.

Supplied in 50-lb. bags. Write today for complete specifications and free sample.

Eagle Insulating Materials include . . .

EAGLE SUPER "66" CEMENT
EAGLE SUPERTEMP BLOCKS
EAGLE L-T FELTS
EAGLE BLANKETS
EAGLE LOOSE WOOL
EAGLE INSULSEAL
EAGLE INSUL-STIC
EAGLE FINISHING CEMENTS

See Sweet's Catalog for specifications

THE EAGLE-PICHER LEAD COMPANY · CINCINNATI, OHIO

"I'D LIKE TO SEE YOU FOR JUST A MOMENT"....

I want to stop long enough to refresh your memory on these vital Viking facts:

All Viking Rotary Pumps operate with only 2 moving parts—here is longer-life, less wear, simple servicing, lower power costs. Compactly designed, Viking Pumps fit snugly in tight places, require less floor space, give a neater installation. A wide selection of drive arrangements, mountings and capacities are available in all standard stock models.

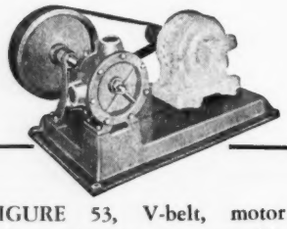


FIGURE 53, V-belt, motor driven unit. Operates smoothly and quietly. Furnished in iron, bronze-fitted or all bronze construction. Available in capacities from 5 to 1050 GPM. Belt guard is standard equipment. Bulletin 103-35 shows both portable and stationary models. Write for a copy.

VIKING PUMP CO.
CEDAR FALLS, IOWA

comparatively short time sufficient disintegration would occur to cause a vacuum leak.

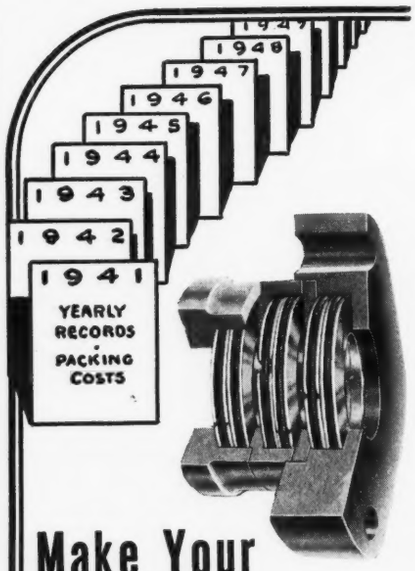
Following the negative results of this initial investigation it was decided to study methods of chemically treating the circulating water. For this test commercial corrosion-preventive liquid, oil and many miscellaneous chemicals were studied at constant and varying temperatures for their general and electrolytic corrosion-retarding qualities. The study revealed several more-or-less promising treatments of the water for retarding general corrosion under the operating conditions of power rectifiers, but only one, a soluble chromate, effectively controlled both general corrosion and the intensified action due to electrolysis.

It was found that a 0.5% solution of sodium-dichromate was sufficient for the average water used as a rectifier coolant. This strength of solution has been found to be sufficient to inhibit corrosion when the solution is made up of any waters of potable purity. Where waters are available which are exceptionally pure, then it is possible to reduce the percentage of solution. A safe solution percentage can be determined definitely by the electrochemical means explained below.

Naturally, the safest solution is made using distilled water, in which there are no foreign chemicals to react with the sodium-dichromate and limit its life as a corrosion inhibitor. Solutions made up of potable waters containing an excessive amount of chloride will require the full amount of sodium-dichromate to obtain full corrosion protection of the dichromate solution.

Before installing anti-corrosive treatment in rectifier-cooling systems it is essential that all metal surfaces be perfectly clean. The coolant is made by adding a sufficient amount of orange-colored sodium-dichromate crystals of technical purity to the water of the cooling system. A 0.5% solution requires 4.2 lb of the crystals to every 100 gal of cooling water. The crystals are readily dissolved in cold or warm water, and when added to the system the coolant should be circulated to speed dissolving action.

To check the effectiveness of the treated water, take a sample of the solution and place it in a glass bottle provided with two iron-wire electrodes spaced about 1 in. apart. Impress approximately 5 volts direct-current potential across the electrodes. Should the solution be weak, a grayish colored formation or precipitate will become visible within 5 to 30 min., about the positive electrode, indicating anodic at-



Make Your Next Packing Job *L-A-S-T!*

During these days of increased production and time-limiting schedules, it is especially annoying and costly to experience shutdowns due to packing trouble.

There is a solution. Install France "Full-floating" Metal Packing in your engines, pumps and compressors. The result is increased efficiency. And each job lasts for years without maintenance expense. Saves money, too, in the long run.

Installation is a simple procedure. See that the rings are installed as lettered to correspond with similar letters on the case. As simple as A-B-C.

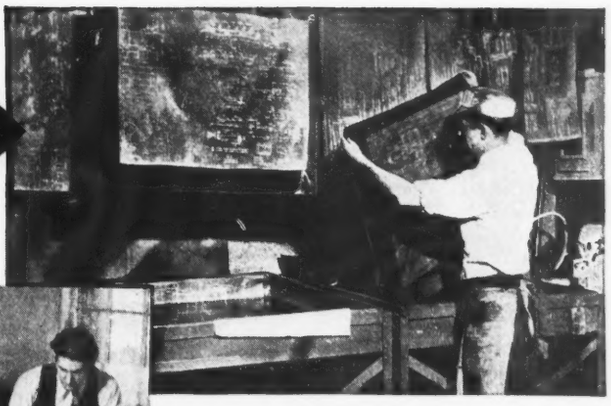
Sold on approval
Satisfaction Guaranteed

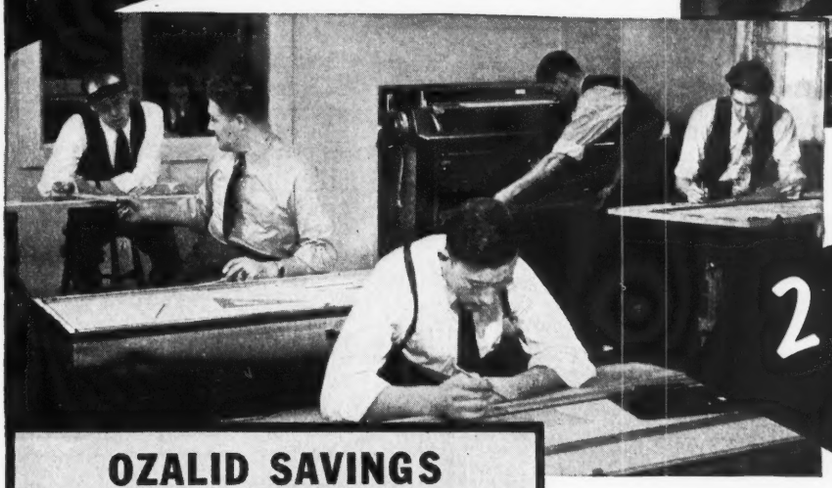
Write for details and Catalog M7. Make your next packing job L—A—S—T.

THE FRANCE PACKING COMPANY
Tacony, Philadelphia, Penna.

Original FRANCE METAL PACKING

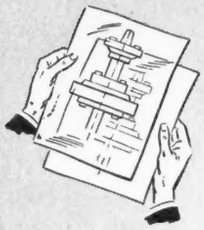
5 OPERATIONS WITH BLUE PRINTING...





2 EASY STEPS WITH OZALID

OZALID SAVINGS



SAVES DRAFTING

Duplicates of originals on transparent paper, cloth or foil for branches or customers are produced in the same simple manner as standard Ozalid Whiteprints.

SAVES TIME

Ozalid Whiteprints are made in two simple operations...(1) exposure and (2) dry development... without washing, fixing, drying or trimming.

1 EXPOSURE

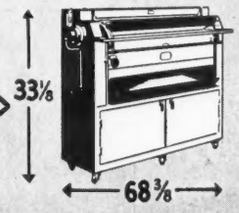
2 DRY DEVELOPMENT

SAVES LABOR AND MATERIALS

In all except the fastest Ozalid Whiteprint machines one operator handles capacity production. Ozalid cut sheets avoids trimming which saves up to one-third in materials.

SAVES SPACE

All Ozalid machines are compact in design and can be installed in any plant, office or drafting room. The Model "F" as illustrated occupies less than 16 sq. ft. of space.



IN rigging your production for an all-out effort, don't overlook your print making equipment. A back number in the print room is a veritable jinx to high-gear performance.

When your print making equipment becomes a bottleneck, it breaks down the co-ordinated steps of production...stands men up . . . ties a knot in your entire operating schedule. Don't wait till your reproduction department bogs down. Your guarantee of a fast, even flow of prints is the adoption of the Ozalid Process.

The Ozalid Process reduces print making to the two simple steps of exposure and dry development . . . completely eliminates three operations in the old-time blue print process and, in addition, provides positive prints, developed dry and true-to-scale.

For prints on the spot . . . in a hurry . . . when you want them, choose the Ozalid Process. There is a full line of Ozalid Whiteprint Machines which do a complete job of print making . . . and for those who already have blue printing equipment which can be used as a printer, there is a selection of dry developing machines.

Send today for illustrated literature on the Ozalid Process and equipment. Free sample booklet of dry developed Ozalid prints on request.

SPECIFY *Ozalid* WHITEPRINTS

OZALID PRODUCTS DIVISION

GENERAL ANILINE & FILM CORPORATION
JOHNSON CITY, N. Y.

Ozalid in Canada • HUGHES OWENS CO. LTD., Montreal

MODERN • • • PRACTICAL

Fyr-Feeder

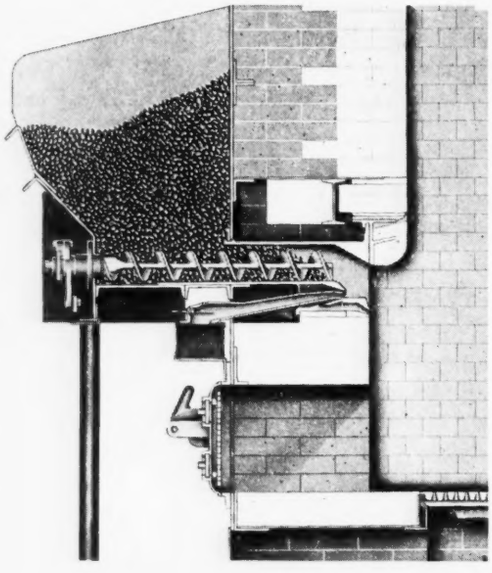
SPREADER STOKER

IS CUTTING COAL BURNING COSTS

★ The list of FYR-FEEDER cost-saving features below shows how you save more money with this oustanding Spreader Stoker—just as many users are doing right now.

FYR-FEEDER is THE outstanding Spreader Stoker and THE one which mechanically carries the coal through the front furnace wall—to inclines inside the furnace. From there it is Spray-Spred uniformly and according to weight-size of each piece, over the grate, by means of double-purpose air streams. The larger coal sizes are placed near the front — the smaller pieces to the rear — the fines burn instantly in suspension producing complete, efficient combustion. **The same air which Spray-Spreds and envelopes each particle of coal spread — burns the fines in suspension.** FYR-FEEDER efficiently burns bituminous screenings, yard sweepings, or coal dust, wet or dry. Write for booklet, "How to Cut Coal Costs."

AMERICAN COAL BURNER COMPANY
151 E. Superior St., Chicago, Ill.
Builders of Over-feed Stokers for Over 22 Years



FYR-FEEDER Simplicity gives you these benefits...

- Ability to Burn Cheapest Coals
- Improve Combustion
- Lower Maintenance
- Lower Operating Costs
- Reduces Banking Losses
- Less Refractory Maintenance
- Less Unburned Carbon in Ash
- Quick Pick-Up—Quick Operation
- Easy to Clean Fires
- Flexible Precision Coal Feed

Each installation is supervised and placed in operation by a competent combustion engineer.

Spray-Spred MULTIPLE **Fyr-Feeder**

REDUCES COAL BILLS - - BURNS CHEAPEST COAL SIZES

tack, which may also be seen on close inspection of the electrode.

The solution should then be strengthened and the test again repeated. Should the solution be of sufficient strength to retard corrosion no precipitate will form around the electrodes. In order to eliminate any possible external influence, it is desirable that all such tests be made at a specific solution temperature, maintaining the same size of bottle and dimensions of electrode.

Sodium-dichromate has been used as a corrosion inhibitor in steel-tank power rectifiers since 1930. During this time all rectifiers in which the inhibitor solution was properly maintained had been free from both the general and concentrated pitting corrosion.

The life of sodium-dichromate solution depends upon the amount of make-up water added to the closed circulating system, and also on the chemical nature of the raw water. Experience indicates that some solutions using mountain waters which are essentially pure have a life in excess of three years. Well waters, which are potable, but have a high impurity content, when made into an inhibiting solution, have a life range upward from nine months.

It has been found that adding a small amount of caustic soda to the chromate solution will increase its effective life. The soda converts the inhibitor to a neutral chromate. A proportion of 1.5 parts caustic-soda to 5 of ordinary crystalline dichromate is sufficient in most cases. Slightly more caustic-soda than this proportion will do no harm. It is advisable to make electrochemical tests of the inhibiting solution, either monthly or semi-monthly, depending upon the character of the water used and amount added for make-up.

Atmospheric Changes Affect Insulation

IN PRACTICALLY ALL ELECTRICAL APPARATUS use is made of the insulating properties of air. The electrical breakdown strength of air, for conditions found in electrical equipment, depends upon air temperature, pressure and moisture content. This situation has long been appreciated and recognized in various standards for testing and for determining insulation rating. However, the range and significance of the extreme conditions encountered is not always understood.

In addition to encountering a reduction in the dielectric strength of air, electrical insulating surfaces, such as porcelain bushings and insulators, fre-

INLET END
Bell mouth reduces aeration.
INLET
EAD SLUG AND FIBRE
BOND BUSHING
rane recommended assembly . . .
owing inlet end of tube with John
rane Style Lead Slugged Fibre
ushing accurately machined to fit
ube size and tube-sheet drilling—
successful bond.
OUTLET END
(re-placing ferrule)
howing patented John Crane
tyle 601-E Endless Metallic Rings
wrapped babbitt foil) and Style
02-G Graphite Fibre Rings (vul-
anized fibre: the swelling mem-
er). When caulked these rings
ow inwardly around the tube, and
utwardly into the drilling threads,
orming a perfect metallic bond
etween tube and tube-sheet.
OUTLET

Who knows what about Condenser packings?

John CRANE!...

Why? 10,000 INSTALLATIONS

IN WORLD-WIDE MARINE and STATIONARY SERVICE

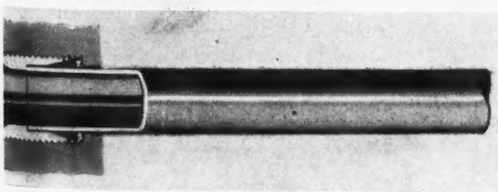
11 *success-points:*

- prevents tube-creeping at inlet end
- replaces ferrules
- accommodates expansion-contraction
- reduces electrolytic deterioration of tube ends
- seals tubes in heat transfer equipment
- facilitates tube replacement
- outlasts tubes
- avoids deforming of tube ends
- resistant to chemicals
- simple installation
- cuts retubing, repacking costs

UNIVERSAL ACCEPTANCE:

(Stationary)	*(Marine)*
Ford Motor	United Fruit
New York Edison	Standard Oil
Pennsylvania Railroad	Matson Navigation
Goodyear Tire & Rubber	American Hawaiian Steamship

Steam plant efficiency depends upon condenser operation, which depends upon tight seal—*which depends upon packing*—and Crane *KNOWS WHAT* packings are the perfect sealing mediums! Here they are: John Crane Style 601-E Metallic Packing and Style 602-G Fibre Rings are caulked into position, and bond the tube to the tube-sheet in a tight, leakproof joint, eliminating ferrules. Methods of installation (including High Pressure Heater Tube Packing) are detailed in Catalog. No. 50.



JOHN CRANE "METAL-TO-METAL" TUBE FITTINGS provide permanent fixation of tubes: no more bowing, fracturing, leaking, deformity; permit removal of tubes from either end; renewable; . . . *the modern, correct medium for "tight" condensers;* available for 4 special adaptations . . . (used by leading naval powers).

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is offered without obligation. Surveys, analyses and recommendations made by our research laboratory on any packing problem or need. Special packings for specific services.

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Save Air—Save Dollars

ROCKWELL BLAST GATES

Threaded Slide Type

Flanged Slide Type

For Low Pressure Air

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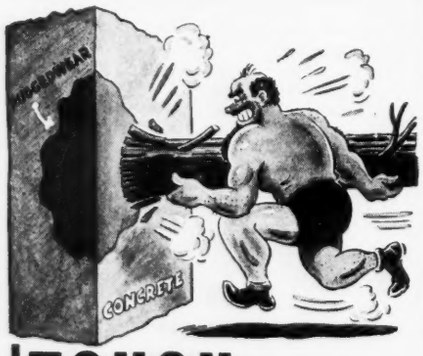

TOUGH REPAIR for BROKEN CONCRETE

Avoid accidents! Prevent costly delays! Repair holes, cracks, broken places in concrete floors or resurface an entire area with the durable RUGGEDWEAR RESURFACER. No chopping or chipping required. Merely sweep out spot to be repaired—mix the material—trowel it on. Holds solid and tight right up to irregular edge of old concrete. Cellulose-Processed to provide a firmer, tougher, smoother, more rugged wearing surface. Used indoors or out. Dries fast. Costs only 10c to 14c per sq. ft.

Valuable 74-page "HAND BOOK OF BUILDING MAINTENANCE" available to those requesting on business letterhead.

MAKE THIS TEST!

FLEXROCK COMPANY
2377 Manning St., Phila., Penna.
Please send me complete RUGGEDWEAR information . . . details of FREE TRIAL OFFER —no obligation.

Name .....
Company .....
Address .....
City ..... State .....

quently are subjected to rain, fog and foreign deposits. A heavy rain will reduce the flashover voltage on a clean insulator 30%. Fog or rain on a dirty insulator may reduce its effectiveness to the point where operation at rated voltage is impaired. In such cases special types of insulators may be applied or periodic cleaning may be necessary.

Electrical-apparatus standards permit using equipment of standard voltage rating for elevations up to 3300 ft. The American Institute of Electrical Engineers' Standard No. 19 for oil circuit breakers states: "For applications at altitudes greater than 3000 ft, it is recommended that the standard voltage rating of the equipment should be multiplied by a factor of 0.98 for an altitude of 4000 ft, 0.95 for 5000 ft, and 0.80 for 10,000 ft."

In a paper, "Atmospheric Variations and Apparatus Flashover," delivered at the AIEE Midwinter Convention, by P H McAuley, the following conclusions were presented:

1. Temperature changes of the ambient air in the United States change the flashover voltage of electrical apparatus through a range of 30%.

2. An elevation of 10,000 ft reduces flashover voltages 30% from those at sea level.

3. Variation in absolute humidity results in changes in flashover voltage of nearly 20%.

4. In any one location the combined effect of these variables is not likely to exceed a 25% range.

5. Standard apparatus applied at different locations in a range of elevation up to 3300 ft will vary in flashover over a possible range of 35%.

6. For many applications standard apparatus of the next higher voltage class fits the mean flashover range of the location.

7. For other cases it is necessary to use special apparatus or to use equipment of excessively high rating to meet the average flashover requirements for the conditions encountered at a given location.

8. The desire to maintain flashover values and to avoid overstressing internal insulation prescribes wide departure from basic insulation levels due to conditions of application.

9. This survey would seem to show greater variations in flashover voltages due to changing weather conditions in service than is generally realized. Although the situation is not to be regarded as alarming, it is well to keep it in mind. A full appreciation of the facts in a particular case should lead

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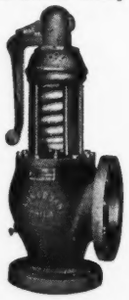

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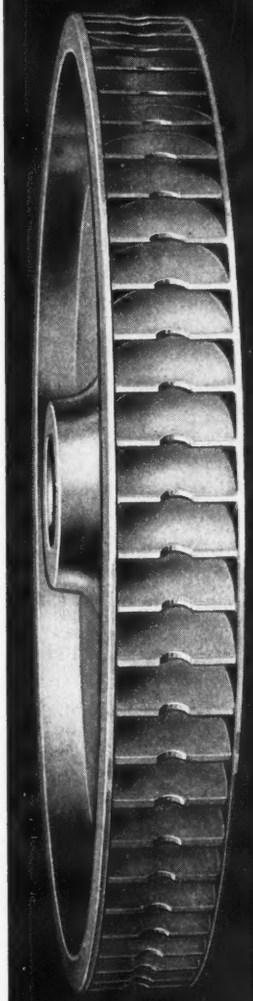

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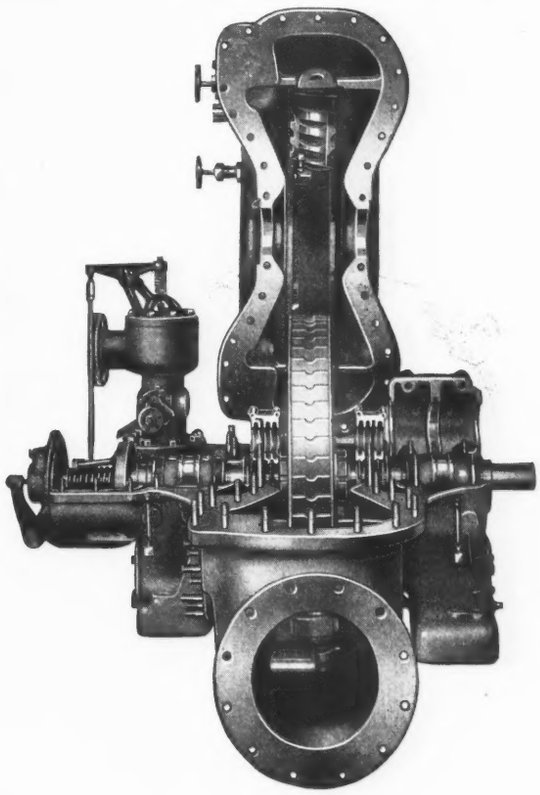

In Terry Wheel Turbines the blades are protected by rims at the sides of the wheel, which would take without damage any rubbing that might occur if the clearance became reduced.

With this construction it is impossible for the blades to foul and frequent inspections of the thrust bearing are not required to obtain safe and dependable operation.

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T-1140

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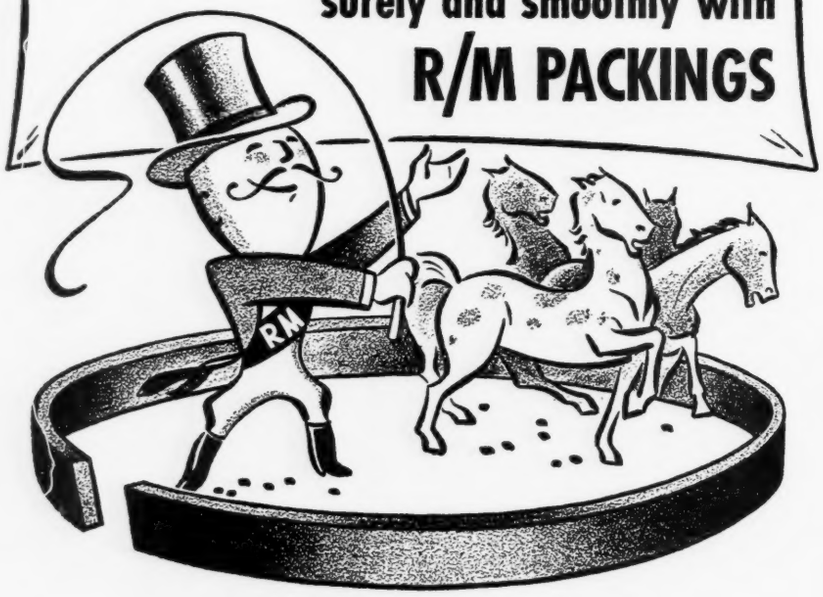

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to a more effective application of apparatus to meet the conditions. On the other hand, certain applications which may have proved unsatisfactory might be explained by these simple natural phenomena. In addition, standardizing groups often find it necessary to consider information of this nature in formulating and revising standards.

Reduction of Noise from Transformers

WHEN TRANSFORMERS ARE INSTALLED near inhabited districts their noise must be limited to unobjectionable values. According to W C Sealey, in a paper before the Midwinter Convention of the American Institute of Electrical Engineers, it has been determined that the audio noise of transformers originates in the change in dimensions (magnetostriction) produced in the core steel by the alternating magnetic flux. The vibration caused by the change in dimensions is transmitted to the air through the tank walls.

Usually, the iron length parallels to the flux lines and decreases in dimensions at right angles to these lines. These changes in dimensions are extremely small. For example, a typical transformer punching 100 in. long will increase in length 0.0002 in. when the transformer is excited at full voltage. Although small, the change in dimensions set up sound waves in the manner common whenever rapid movement of a solid (in this case the steel) in contact with an elastic medium (air or oil) occurs.

It is general experience that the noise of a transformer varies with its size and that large transformers are usually more noisy than small ones. It is also known that the noise of a given transformer increases as the applied voltage is increased. That is, the sound level of a transformer increases as the induction in the iron is increased.

It was found that radiators have little effect on the sound level when measured at one foot from the major sound-producing surface, in accordance with the latest standard. In general, transformers with higher exciting currents, compared with identical transformers using lower exciting currents produced higher sound levels, but additional investigation is required before general conclusions on this subject can be offered with confidence.

The reduction of the sound level of transformers is most effectively secured by reducing the induction in the iron. To produce quiet transformers it is

"AND HERE'S ANOTHER POWER COMPANY THAT SELECTED LIMITORQUE"
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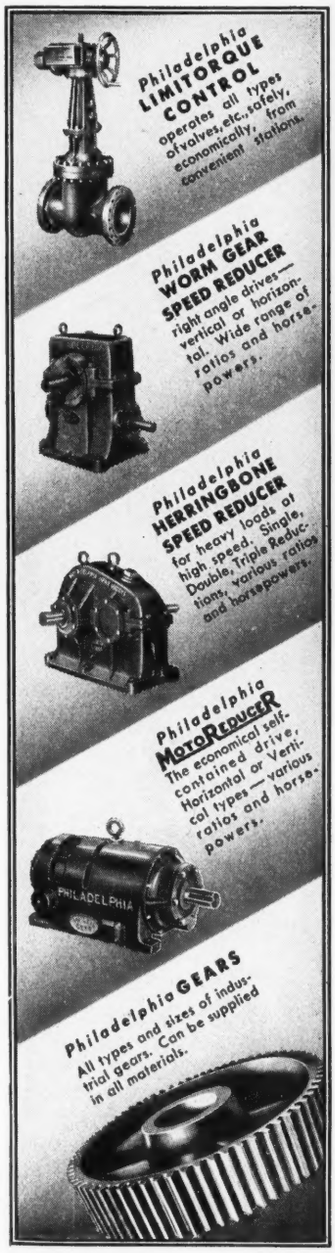
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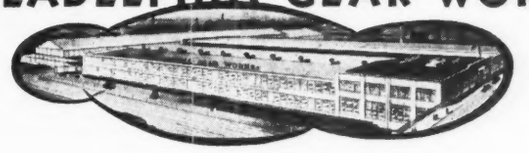

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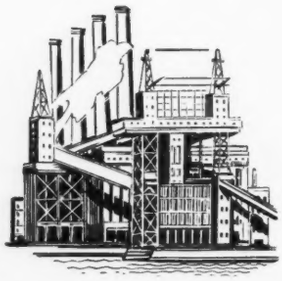

The defense program demands uninterrupted service of power plant equipment. Engines and pumps *must* be kept operating at maximum capacity, sometimes twenty-four hours a day—no time for frequent packing replacements.

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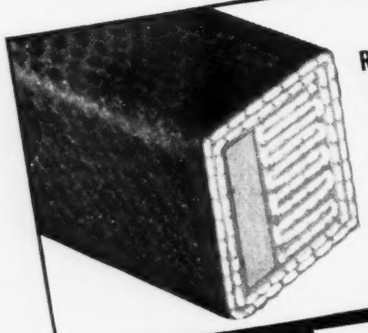

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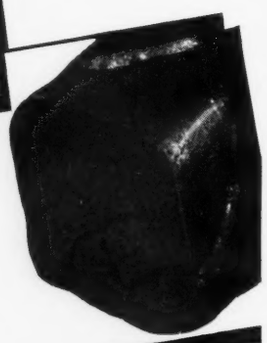

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Practical and reliable for rotating shafts, all temperatures.

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necessary that parts be so constructed that resonant vibration is negligible. No successful method of reducing the transmission of sound to the air has been developed so far.

Generally most of the objectionable sound is borne by the air. In cases where sound is conducted through the support, sound-insulating devices may be used, but the solution is difficult owing to the large low-frequency components of the sound.

Capacitors Double Transmission Distance?

USE OF SERIES CAPACITORS with conventional overhead lines appears to be the most favorable of all methods proposed for transmitting 60-cycle power greater distances than it is carried at present, according to Miss Edith Clarke and S B Crary, of the General Electric Company's Central Station Engineering Department.

Presenting a technical paper on the "Stability Limitations of Long-Distance Ac Power Transmission Systems" before the winter AIEE convention at Philadelphia, January 28, Miss Clarke and Mr Crary stated that the use of the series-capacitor method should make it possible to maintain present-day circuit loadings for 60-cycle power for distances of 600 or 700 miles.

The authors pointed out that one of the limitations of the transmission of alternating-current power long distances is the ability to keep parallel-operated generators and other rotating equipment in synchronism. Technical aspects of this limitation were discussed and data were presented for the determination of the loading and distance to which it is possible to deliver power.

Existing lines for the straightaway transmission of power are limited economically to about 300 or 350 miles. "Of all the methods proposed for transmitting 60-cycle power to greater distances, possibly 600 to 700 miles, and with loadings equal to or exceeding those of existing lines, the series capacitor used with conventional overhead lines appears most favorable," the authors said.

Q—What is factor of evaporation?

A—Equivalent evaporation divided by actual evaporation gives factor of evaporation. This may be expressed another way: factor of evaporation is the actual heat absorbed in converting feedwater to steam, divided by the latent heat of vaporization at atmospheric pressure.

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That's why we're so proud of our Youngstown steel makers, many of whom have had long years of experience in our mills. These men might surprise you with their knowledge of what you want in pipe. If you could watch them work, see how they use this knowledge to make a better product, it would give you even more confidence in the dependable quality of Youngstown Pipe.
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Right now, at the beginning of the season and before algae growth begins, is the time to solve those problems—*with Santobrite!*

Santobrite (sodium pentachlorophenate) was developed by Monsanto for use in recirculating cooling water systems where the water is not used for drinking or bathing. Easy to handle and apply, low in cost, Santobrite keeps the system free from growth . . . makes for peak efficiency at all times.

Preventive treatment early is much simpler and less expensive than treatment to destroy accumulated growth. Write today for a copy of Monsanto Technical Bulletin 0-15, "Santobrite for the Control of Slime and Algae." MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, St. Louis, U.S.A. District Offices: New York, Chicago, Boston, Detroit, Charlotte, Birmingham, Los Angeles, San Francisco, Montreal, Toronto, London.

QUICK FACTS ABOUT SANTOBRITE

1. Essentially unreactive chemically . . . stable in presence of organic and inorganic substances.
2. In concentrations used for algae control, will not attack metals commonly used in engineering practice.
3. Compatible with other water treatments.
4. Uniformly effective as an algaecide throughout pH range found in cooling practice.
5. Available in one-ounce briquettes, 7 pounds to a cotton bag, 10 bags to a container.
6. Can be applied by simply suspending bag in cooling water.

Detailed directions in Technical Bulletin 0-15.

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Midwest Conference Program Announced

The preliminary program for the Midwest Power Conference, to be held at the Palmer House, Chicago, Ill., April 9-10, has been released. The conference is sponsored by the Illinois Institute of Technology, with the cooperation of Iowa State College, Michigan State College, Purdue University, State University of Iowa, and the Universities of Illinois, Michigan, and Wisconsin. Cooperating chapters of engineering societies are also taking part.

At the opening meeting an address, "Power Facilities and the Defense Program," will be presented by C W Kellogg, group executive, the Advisory Commission to the Council of National Defense. A G Christie, professor of Mechanical Engineering, Johns Hopkins University, will give a "Resumé of Present-Day Power Trends." Other portions of the program follow: *Central Station Practice,* "Forced Circulation in American Power Plant Practice," W H Armacost, chief engineer, Superheater and Economizer Div, Combustion Engrg Co, Inc, New York; "Modern Steam Turbine Design," C C Franck, engineer in charge of Central Station Turbines, Westinghouse Electric & Mfg Co; "Variable-Speed Drives for Power Plant Auxiliaries," G V Edmondson, district hydraulic coupling specialist, American Blower Corp.

Hydro Power: "Hydro Power and the National Emergency," R B McWhorter, chief engineer, Federal Power Commission, Washington, D. C.; "The Operation of the Multi-Purpose Projects of the Tennessee Valley Authority," Sherman M Woodward, chief water control planning engineer, Tennessee Valley Authority; and a paper, title unknown at press time, to be presented by W J Rheingans, test engineer, Allis-Chalmers Mfg Co.

Electric Power Transmission: "The Limitations Placed on Power Transmission by System Stability," H E Wulfing, system development engineer, Commonwealth Edison Co; "Trends in Equipment Design," W J McLachlan, General Electric Co. *Industrial Power Plants:* "Increasing Power Production with Present Boiler Facilities," R S Hawley, acting chairman, Department of Mechanical Engineering, University of Michigan; "Instruments and Control," Charles W Parsons, Republic Flow Meters Co.

Feedwater Treatment: "Removal of Gases from Boiler Feedwater," Arthur E Kittridge, chief engineer, Cochrane

(Continued on page 202)

Pittsburgh — FOR THE ASSURANCE OF SEAMLESS!

Pittsburgh Boiler Tubes are *Seamless*— pierced from solid billets of sound steel, for *only sound steel* can withstand the severe piercing process! Because they are *Seamless* the walls are of uniform ductility and homogeneous steel structure throughout.

Thus, when you have made an installation of *Pittsburgh* Seamless Boiler Tubes, you have the *assurance* that, throughout the combined length of all the tubes, totaling hundreds or thousands of feet, there is not a single line or point of potential weakness (where a *weld* may be less than perfect), because first, last and always *"Pittsburgh"* Boiler Tubes are *Seamless.*

Whether for locomotive, stationary or marine boilers, for fire tubes or water tubes, for average pressures or high pressures, for straight tube or bent tube applications, *Pittsburgh* Seamless Tubes will give long and dependable service.

Available in a full range of sizes and wall thicknesses, hot rolled and cold drawn, regular low carbon analysis or with copper or other alloy metals as required. Popular items stocked by distributors in a number of cities. Tubes furnished bent to specifications if desired.

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OUTSTANDING BONDING STRENGTH

Tests made by an impartial leading technical laboratory on the average modulus of 5 test joints of

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showed that it has the exceptional bonding strength of *800 lbs. per sq. inch at room temperature . . . 1270 lbs. per sq. inch at 2600°F.* This outstanding strength makes Adamant joints really stronger than the brick they bond. This is proof of the fact we make Adamant as high in quality as possible . . . not just to meet price. The longer furnace life it provides is its economy. Write for full details. Also ask about our complete line of refractory products.

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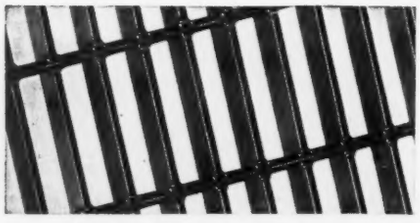

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Corp; "Water Treatment Problems in the Steam Power Plant," Frederick G Straub, Research Associate Professor of Chemical Engineering, University of Illinois.

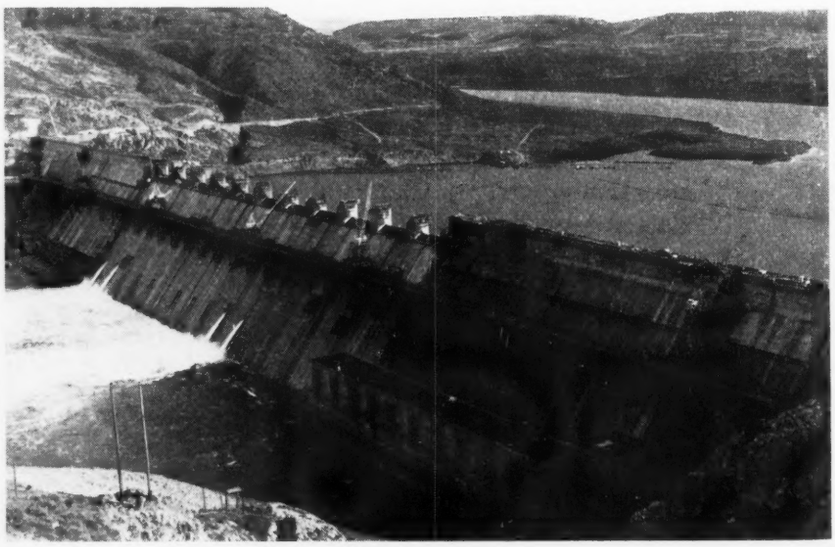
A joint luncheon with the American Institute of Electrical Engineers is scheduled for Thursday, April 10, at noon. Frank V Smith is chairman and the speaker is Major Charles W Leihy, formerly editor, *Electric Light & Power.* Topic is "Aspects of the National Power Pool, Defensively and Afterwards."

Following the technical sessions an inspection trip through the Tractor Works of the International Harvester Corp has been planned. Further information concerning special functions and meetings of the conference can be obtained from C A Nash, conference secretary, Illinois Institute of Technology, 3300 Federal St, Chicago, Ill.

LARGEST SINGLE-SLOPE CONVEYOR

Photo shows largest single-slope conveyor belt being installed for the Fifth Vein Coal Co, Harrisburg, Ill. It was built by U. S. Rubber Co, and is the first conveyor belt made of 48-oz duck. The belt is 1530 ft long, 9-ply, 54-in. wide, and weighs 35,000 lb. It has a capacity of 1000 tons per hr of run-of-mine coal at 350 ft per min and lifts it 206 ft up a 16.5-deg slope

GRAND COULEE NEARING COMPLETION



Three times as large as anything ever built by man, the Grand Coulee Dam, started in 1933, is nearing completion. Built by the Bureau of Reclamation, the dam is 4500 ft long, 553 ft high, 500 ft thick, and, required 11,250,000 cu yd of concrete. Two power plants will have an ultimate capacity of 2,742,000 hp. Connected with the project is a 750,000-hp pumping plant to supply water for irrigating 120,000 acres